PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

JANUARY, 1938

A. PRESCOTT FOLWELL, Editor VOL. 69, NO. 1 W. A. HARDENBERGH, Asso. Editor

Contents

TIMEWASTERS

New Year Greetings:

Spherical trigonometry was evidently a middling poor diet over the holidays. Mr. Blunk's airplane problem scared away most of the folks; and very few could stomach the Mississippi problem. As to the first, Mr. Blunk says—and we are not the one to argue with him—that the planes flew for 36 hours, and that they started at 3 min. and 36 seconds past 8 o'clock in the morning. As to the Mississippi, due to the flattening of the earth at the poles, we find that New Orleans, which is at the mouth of the river, is 4 miles farther from the center of the earth than Lake Itasca, the source.

Five Apples and Three Boys:

One boy who had 3 nice apples, met another boy who had 2 apples, equally nice. A third boy without any apple, but the proud possessor of 10 pennies, joined the first two. They agreed to pool their resources. The apples were equally divided. Then the question of the division of the 10 pennies arose. The boys could not arrive at a satisfactory solution, so they asked the policeman on the corner, who gave the correct answer. How were the pennies distributed?

More Apples—and a Headache:

The fruit store proprietor received a box of apples and arranged them in the form of a square based pyramid. When it was all done, his wife complained that the pyramid of apples was so high that she couldn't look out of the window. He then rearranged them into two smaller triangular pyramids. The bottom or base layer of each of the triangular pyramids of apples contained 12 less apples than did the bottom layer of the square-based pyramid. How many apples were there in the box?

A Joy Ride for Ikey & Mikey:

A freight train one mile long was standing on a siding. Mikey got on the rear end of the train, which proceeded on its way. Mikey also proceeded to walk forward as he wanted to see Ikey, who was the fireman. The train stopped at a station exactly 9 miles from the siding where Mikey climbed on. How far did Mikey ride?

That should be enough for now. Hoping you all had a nice holiday time. W. A. H.

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Turn to Pages 63-65 for descriptions of helpful booklets and catalogs.

JANUARY, 1938
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PUBLIC WORKS
City, County and State
Engineering and Construction

Methods of Controlling Ice on Cleveland Streets

By CHARLES J. SHEETS
Commissioner of Streets

With this article, we more or less place Mr. Sheets on the spot in making him responsible for the weather during the Road Show; or, if not for the weather, at least for keeping the streets free of ice. We believe he can be relied on to do so, for we personally know that during an early December ice storm, Mr. Sheets and his organization did a good job for which we congratulate him.

THE City of Cleveland is proud of its record for maintaining the safety of its streets in the wintertime, a record that has resulted in visits by officials from other cities to study the system used. A principal reason for success is an efficient and well trained sleet and snow-fighting organization. The city has four main garages or stations strategically located so that the crews can cover established routes quickly.

Whenever streets become coated with ice from any cause, the ice control crews swing into action. A total of about 300 miles of streets are regularly covered. All of the main streets and boulevards are freed from ice and snow in the shortest possible time after the need arises. When snow becomes thick enough to hinder traffic, it is plowed from the streets to the curb and removed in trucks. Usually the snow-plows start out when the snow is 3 or 4 inches thick. We aim to remove the snow entirely from the center of the city and in the more congested districts before it becomes packed on the pavement. The snow-plow always leaves about one-half inch of snow. If this layer of snow is soft enough, hand scrapers are used to shove it to the curb out of the way of traffic. This work is concentrated first at traffic lights and important intersections.

We do not like to leave any snow on our streets in business sections, especially at the traffic lights and in the Public Square. Whenever it is not possible to remove all the snow with snow-plows and hand scrapers, we use a thin spread of rock salt at the rate of about one-half pound per square yard of surface either to melt all the snow or soften it so it can be scraped to the curb.

When weather reports indicate a heavy snowstorm, our crews make ready, and when the storm begins, start out with trucks of rock salt. This is spread at important locations ahead of the snow-plows, at the rate of about one-half pound of salt per square yard, keeping the snow from packing before the snow-plow arrives, and also preventing the scraped-up snow from freezing before the trucks can haul it away. This enables the snow removal trucks to continue operating at temperatures which would otherwise freeze the piles of snow.

Our streets are surfaced with asphalt, brick, cobblestone and granite blocks. We prefer to use the salt without mixing it with sand or cinders; first, because we want to remove the snow from the streets as completely as possible and, second, because abrasive material would create a street cleaning problem and tend also to clog our sewers.

On the hilly sections and some outlying streets, a mixture of 50-75 lbs. salt to 1 cubic yard of cinders is used, both on sleet and packed snow. Here again we want to get rid of the snow and ice, and the excess of salt permits using fewer cinders to be removed later.

For sleet and light snows that melt and then freeze with falling temperatures, the crews stand by and begin spreading rock salt as soon as the streets become slippery. Principal streets, boulevards and main intersections are treated first. Salt is applied near all main traffic lights and also in the center of the block about half way between consecutive traffic lights. Wheels of automobiles distribute the salt for some distance beyond these sections and in time over the entire surface.

Spreading is from dump trucks either by rotary spreaders or hand, and the amount used varies according to the temperature and weather conditions. Usually the rate of application varies from one-half to three-quarters of a pound per square yard of surface. We find that the rotary spreaders are more economical and effective over long stretches of city streets and boulevards, while hand spreading works well on short sections. When spreading by hand from trucks, two men stand in the back of the truck, working with shovels, while the trucks travel at the rate of 7 to 9 miles per hour.

Crews operate in day and night shifts during periods of emergency and are subject to call at all times. About

(Continued on page 24)

Spreading pre-mix seal coat mixture on an Alabama highway

Surface Treatment on Stabilized Bases in Alabama

By H. H. HOUK

Chief Engineer, Alabama State Highway Department

WHERE suitable materials are economically available within or without the roadbed, the logical design of a highway to serve average traffic conditions is a flexible surface on a soil-mortar base course. Soil-mortar or stabilized base courses should be considered integral parts of low cost surfaces, and when composed of mineral aggregate soil constituents of the proper character, gradation, proportions and thickness they make, with the wearing surface, a stable layer or pavement that will deliver traffic loads to the soil.

To some engineers in the past, the building of a roadbed has seemed a simple operation: the soil, aside from handling operations, appeared to offer little opportunity for the exercise of engineering knowledge or the application of mathematical principles. Soil was just "dirt"—material already made, and, like the weather, nothing could be done about it. On the other hand, the wearing surface or pavement was something to be designed and built, something artificial and offering opportunities to exhibit engineering ability and training.

Soil stabilization, when applied to foundations for pavements usually means changing the character of the existing soil by adding natural or artificial material to a designated depth of the existing road-bed soil to increase its stability. This is practical and successful only when the road-bed material is of such a character that it will form a stable mixture with the material added. Soils that need treatment are usually unsuitable for binder. A stabilized base should remain intact throughout such soil movements as come with time; and it should be possible to true it up, as needed, at intervals of several years, to its original or better condition at a minimum expenditure.

With less than one-fourth of the state highway system paved and early reconstruction of the first of these pavements becoming imperative, the Alabama Highway Department was finally forced to recognize the fact that, while two bond issues of 25 million dollars each had been spent, they had built only a very small mileage of all-weather road for which the taxpayer was receiving full value in service; and the further fact that, unless all-weather roads could be provided at lower costs, completion of the paving of the State highway system would be postponed indefinitely, and extension of the system would be impossible.

Several bituminous road-mix projects were constructed on foundation courses of gravel, of chert, and of roadbed soil to which aggregate had been added and mixed. A number of these proved successful failures; successful, because they forced Department engineers to cognizance of the fact that, just as in any other engineering structure, the traffic loads carried by the wearing surface or pavement must finally be delivered to the soil every day in the year, regardless of soil changes due to climatic variations, without overburdening it and in such a manner that any soil changes will not damage the wearing surface or pavement.

The bituminous surfaces failed wherever the base course mixture of gravel, chert or aggregate and soil failed to deliver the traffic loads to the soil on account of excess of plastic clay binder which caused the base or foundation course to become unstable in wet weather. At first these failures were attributed to defects in bituminous cement, improper grading or mixing of aggregates, and to every other possible factor in the materials, design and construction of the bituminous surfacing. But careful observation and thorough investigation by Alabama highway department engineers

finally disclosed that every square yard of bituminous surface that had been placed on a soil-mortar base course 6″ or more thick, stable under all weather conditions, has remained in perfect condition since completion with no surface maintenance whatever.

Alabama's Low-Cost Road Type

After investigation, experimentation and study of service behavior, the Alabama Highway Department has selected and improved for its low-cost surfaced road the type commonly known in the Southeast as double surface treatment and in the West as "armor" coat. The type used is actually ¾-inch to 1-inch inverted penetration with a pre-mix or mixed-in-place seal coat of 25 to 50 pounds per square yard.

The essential design features of this type, which is very stable despite its flexibility and therefore well adapted to regions with heavy rainfall and deforming subgrades, are:

1. A thoroughly compacted soil-mortar base course of local granular material and binder, of sufficient thickness and stability to deliver the traffic loads to the subgrade soil under all local climatic conditions, properly shaped to easy riding grades and true cross section.
2. A moisture-resisting bituminous prime coat penetrating into the top of the base course sufficiently to provide bond and a gradual transition between the granular soil base material and the granular bituminous surfacing material.
3. A layer of elastic bituminous material applied hot, in which a single layer of uniform-sized aggregate becomes firmly embedded under light rolling followed by controlled traffic.
4. A single layer of good quality hydrophobic coarse aggregate to which the bitumen will adhere well, as nearly of uniform size (¾, ⅞ or 1-inch as desired) as is economically practicable.
5. A seal wearing coat composed of elastic bituminous material and tough, durable fine aggregate, properly graded to fill the voids in the coarse aggregate layer and provide a smooth non-skid surface, applied after the coarse aggregate layer has been subjected to traffic long enough to become thoroughly keyed and interlocked together.

The Base Course

The thickness of base course material necessary is governed by the character and condition of the subgrade, the character of the base course material and the volume of traffic. A good surface, no matter how thick, cannot overcome base and subgrade weakness.

Rolling pre-mix seal coat

Much of the surfacing in Alabama is placed on roadbeds that have been graded and drained and that have been surfaced temporarily or longer with top-soil, sand-clay, sand-clay-gravel, chert or crushed stone. Every effort is made to preserve the existing compacted "stabilized soil" and soil mortar layers on these old roadbeds as they have been improved by time and traffic. Unless specifically warned not to do so, construction forces are prone to scarify the existing surface, thus destroying the compaction, in order to shape up a subgrade to receive the base course layers. What they do not realize is that all soils, except those that change greatly in volume with change in moisture content, become compacted under traffic to a degree that cannot be attained by construction methods; and that, even though the roadbed soil was originally of poor quality, in most cases it has become so stabilized through weathering and compaction that to disturb will reduce the strength and stability of the subgrade and foundation.

Therefore, on old location a leveling course of stable soil or base-course material is placed wherever necessary to correct approximately the profile grade and the cross section, in advance of placing the base-course.

Using a cotton mat. Left, spreading coarse aggregate; right, applying bitumen

Small batch mixer set up at quarry to make pre-mix seal coat; 200 tons per day output

The entire area adjacent to every project is carefully prospected in advance of construction and every available source of material suitable for use in soil-mortar mixtures investigated and studied. The economical mineral aggregates and soil constituents of the character and gradation required for stable soil-mortar mixtures, as they occur in combination, are selected for use on the project. For example, when the local material available contains an excessive percentage of clay, aggregate and binder are added to reduce that percentage and produce a soil-mortar mix of proper proportions.

The base course material is spread to proper grade, line and cross section, and every effort is made to maintain it as nearly to the true section as practicable while traffic is producing proper compaction.

Base courses are much more stable, and the surface remains even and smooth much longer, where the base course is properly shaped from the start and traffic so routed that uniform compaction over the full width of the base course is obtained. There is no complete substitute for traffic compaction in securing density and stability in base course construction, although results can be obtained closely approaching traffic compaction with multiple-wheel or tamping rollers.

A well compacted, stable soil-mortar base course of sufficient thickness to properly deliver the load to the subgrade has a density which prevents the ready penetration of water from above or below, and eliminates the necessity for subdrainage or underdrainage except in the extraordinary conditions where subsurface flows or collections of water in the subgrade are encountered.

In certain sections of the nation open, sand-gravel or stone sub-bases are used over tight, dense subgrades that hold the water up in these bases unless drained away. Inequalities, existing or that come with time and traffic, in the surface of any but pervious soils under porous base courses become reservoirs for holding free water which it is impracticable if not impossible to entirely drain away. Such water is a source of weakness and destruction. Again, if a porous base course is used over a plastic soil without first blanketing it with an insulating layer of fine granular material, the soil tends to work up into the interstices of the base course, render it unstable and destroy the wearing surface. Much of such expensive sub-drainage could often be dispensed with if a properly designed dense soil-mortar base mixture was used in the base course instead of porous open mixtures.

The Bituminous Surface

The bituminous surface must be placed under favorable weather conditions. Many failures can be traced to attempts to carry on the work too late in the fall during damp cold weather.

The Department engineers are continually striving to improve this bituminous design to meet different local conditions. Modifications are necessary for its successful use under different climatic conditions. It is possible that the type might be entirely unsuitable in some climates or under some traffic conditions, but where properly constructed in localities of average or heavy rainfall on a stable base course of adequate thickness, its traffic capacity is unlimited.

The design is inherently stable and flexible. The uniform-size particles in the coarse aggregate layer carry the traffic wheel loads directly to the base course without transmission from particle to particle or any movement of aggregate on aggregate. The aggregate is embedded in a heavy elastic layer of bitumen that extends down into the top of the base course and is an integral part thereof. The single layer itself is weatherproof, and where the maximum particle size has been held to ¾ inch or less, it has been used as a single-course wearing surface for years without a seal coat.

The seal coat, however, smooths up the surface, interlocks the coarse aggregate particles and takes the wear which is often excessive on soft or friable aggregates. As the seal coat wears down, or if it becomes necessary with the lapse of time and the deformation of the base course or subgrade to true up the riding surface, additional seal coats or retreads can be added at a nominal cost and the public, in effect, given a new pavement.

The grade, character and amount of bitumen that should be used in any given locality can be determined only by the results of experience. The differences of opinion over the country as to the proper kinds and amounts are traceable to climatic and other variations and not to fundamental differences in design. Many bituminous surfaces constructed with grades of bitumen and on makeshift bases which prove reasonably successful in arid sections would not survive one month's wet weather in other parts of the country.

There never has been a time in road building history when the need was greater for accurate information and sound unbiased judgment in dealing with the road problem. Free, clear thinking on the fundamentals of foundation, base and surface or pavement design has been too long obstructed. It is a waste of public funds to build highway surfaces and pavements of an expensive type not required by either present or prospective traffic. Hundreds of thousands of miles of roads must be built and improved to bring the people from their homes to the arterial highways. Service requirements demand that they shall be all-weather roads, and the cost of their improvement and their upkeep must be within the ability of the highway user to pay. If the highway engineering profession is to discharge its duty of providing adequate transportation service for all, it must exercise uncommon judgment, exert uncommon effort and exhibit uncommon vision or it will unwittingly contribute to the bankruptcy of the taxpayers who are in the main the highway users.

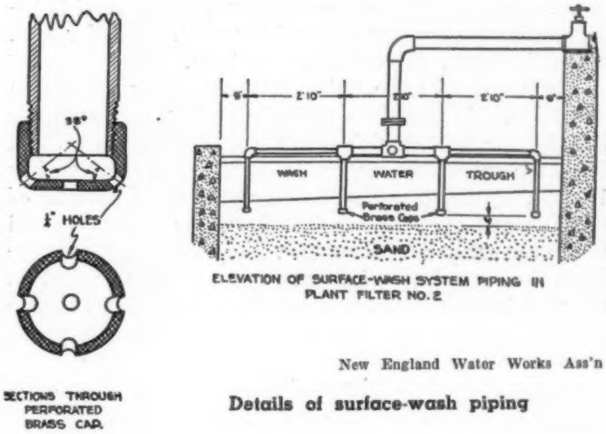
Water Filtration During 1937

New ideas and developments discussed in the various papers and articles of the year, as summarized in the "Water Wheel"

FILTER SAND. Present engineering practice is to use sand having an effective size between about 0.40 mm. and 0.55 mm., with some indication of a tendency to adopt the coarser sands where permitted by consideration of the various other factors entering into plant design and maintenance. Experimental studies made by the A. S. C. E. Committee on Filtering Materials, cooperated in by plants in 16 cities, indicate that coarser sands produce longer filter runs, produce better "efficiency of wash," and permit greater penetration of floc and thus necessitate a thicker sand layer. Criteria selected for judging the suitability of any particular filter sand were: (1) Its efficiency in removing suspended matter; (2) its ability to pass a large volume of clear water between washes; (3) the ease with which it can be cleaned by the application of wash water. A filter run was considered complete when the loss of head reached 8 ft. at 125 mgd. per acre, or when the effluent turbidity exceeded 0.2 ppm. The shortest runs were those caused by presence of micro-organisms. Conclusions reached tentatively were: A good effluent can be secured with any size of sand, if of proper depth, which should increase with sand size. For sand of uniform size, the critical depth, which is roughly proportional to the square of the diameter of the average size of the sand grains, can be used as a guide. For a graded sand, the depth of a filter bed may be designed correctly if a sieve analysis of the proposed sand and the critical depth of each grade are known ("Critical depth" = the maximum depth to which silt will penetrate into a bed of uniformly graded sand up to a loss of head of 8 ft. when the filter is delivering a clear effluent at a rate of about 125 mgd. per acre).

The "permeability" of filter sand is a function of the viscosity of the liquid and of the porosity, size, shape and gradation of the granular material. Tests at the Iowa Institute of Hydraulic Research led to conclusions that it varies inversely as the viscosity of the water; as the 6th power of the porosity for angular Iowa river sand and as the 5th power for rounded standard Ottawa sand; and as the square of the diameter of the sand grains; was 50% greater for standard Ottawa sand than for angular Iowa river sand having the same grain sizes and porosities.

Filter sand with a low uniformity coefficient for use throughout the entire filter bed is neither necessary nor altogether desirable; for the sand lying in any horizontal plane in a well-washed filter bed has a uniformity coefficient approaching unity, and a graded sand will prevent an abrupt break between sand of the "effective size" and the top gravel layer. A uniformly graded sand will give good results provided the proportions passing a No. 30 sieve are carefully controlled to give a proper filtering layer on top of the filter.



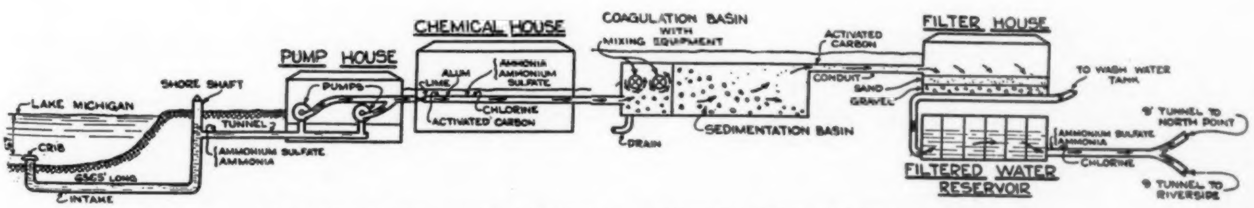
New England Water Works Ass'n

Details of surface-wash piping

Gravel satisfactory for filters is becoming scarce, which adds interest to the development of filter bottoms which reduce or entirely eliminate the gravel.

Filters using anthracite coal as a medium, with effective size of 0.60-0.70 and a uniformity coefficient of 1.60, have been used for a number of months at four stations of the Philadelphia Suburban Water Co. in parallel with sand filters. Daily color and turbidity readings of the effluents showed no significant difference between sand and coal filters. The chlorine residual carried through the sand filters was greater than that through the coal. Bacteriological results were uniformly excellent, slightly better with the sand filters. Coal filters used 27% less wash water at one station, 42% less at another.

Filter Washing. Rate of applying wash water should increase as sand size and water temperature increase; up to 24" per min. for fine graded sands, and to 30" for 0.6 mm. sand; and 40" to 50" for 0.76 to 1.75 mm. Sizes of 0.5 mm. or less give short runs; 0.6 to 1.0 mm. give satisfactory results; 1.00 to 1.75 mm. give excellent results with adequate depth and rate of wash. Apparently, an ideal filter would be composed of sand of uniform size, which gives greater uniformity in hours of service and in efficiency of wash. (This would not seem to be possible if the sand rests on gravel, but would



Flow chart of water passing through the Milwaukee plant, 200 mgd. capacity

be if supported by diffusion plates or other material through which the sand cannot pass.)

Sand expansion in filter bed washing has been measured at Allentown, Pa., by means of a float, counterweight and indicator, the float remaining at the surface of the sand as it rises. The counterweight should weigh about 87% as much as the float, but this varies with the kind of filter medium; water temperature and depth do not affect the accuracy. The float was in the shape of a cone with a convex base loaded with lead, the specific gravity somewhat exceeding 1.7. The sides of the cone must be steep enough to prevent sand lodging on them—45° was adopted for sand, 51.4° for coal, and a 100 mm. diameter for the base.

Wash water at the Salem-Beverly, Mass., filtration plant is discharged into three lagoons in a swamp adjoining the lake, which operate in series, the effluent from the third flowing into the lake. After operating 16 mos. the third lagoon had not yet filled because of seepage and evaporation, but the water in it appeared to be better than the lake water. They also receive sludge from the coagulation basins, some of which floated on the first lagoon (but later sank), and occasioned some odor. There has been no considerable amount of algae growth.

At Denver, Colo., the wash water is discharged into a basin, from which it is drawn off for irrigation in summer, and pumped back to the mixing basin in winter.

A chief cause of filter bed trouble is incomplete cleansing of the sand, which may cause shrinking, cracks and mud balls. Also jet action at the sand-gravel junction causes ridging of the gravel, even permitting sand to work down into it. Gradual transition of size at the sand-gravel junction is advised. Washing at a high rate keeps filters in better condition than at a low one, but neither this nor periodic restoration is a satisfactory solution. According to John R. Baylis "The use of jets of water from a piping grid located above the sand and known as the surface washing system offers the only known practical means of keeping the sand beds as clean as they should be kept. This is used in addition to back washing and at the same time." From 2 to 8 gpm. per sq. ft. of water is used for surface washing, depending on the tendency to clog; few will require more than 3 to 4 gpm. when the pressure head at the jets is 20 to 50 ft. One-quarter-inch holes should be used for pressure heads less than 50 ft., smaller sizes for higher pressures. The holes should be in brass pipe rather than iron. Maintaining filters in excellent condition by use of the surface washing system is not costly.

Cleaning filter sand with acids was studied at Chapel Hill, N. C., to compare the cleaning efficiencies of caustic soda, sulphuric acid, hydrochloric acid, nitric acid, chlorinated lime and soda ash; determine the strength of chemical solution and period of contact with the sand that gave the best results; and the best method of applying the solution. Used with Chapel Hill water, sulphuric acid was found to have the highest cleaning efficiency, cost least, cleaning with it would keep a bed out of service not more than an hour, completely removing the sand grain coatings without damaging silica sand. Unfavorable factors were danger of corrosion of metal parts of the filter and of damage to the concrete filter box. "Experiments with a 2 ft. diameter filter indicate that penetration of acid into the bed takes place most slowly when the water level is drawn below the sand surface and the acid sprayed on the bed. The sand should be raked, following application of the acid, to break up mud balls and to bring the chemical into contact with all the grains near the surface." Further investigation is needed of protection of underdrains and filter box from acid, and full-scale demonstration of the practicability of using strong acid solutions for short contact periods.

Slime on filter walls, fairly thick in many places, was found to be the breeding place of 20° bacteria which appeared in the filter effluent of the Salem-Beverly, Mass., plant. This could not be removed by strong doses of hypochlorite or by copper sulphate; but when the wall surface above the sand was scrubbed with stiff brushes, followed by heavy hypochlorite treatment and several filter washings at increased flow, the trouble disappeared, and there have been neither further slime deposits nor trouble from bacteria.

Sub-surface filtering at Toledo, O., began in December, 1935, with reconstruction of a sand filter, increasing sand depth from 24" to 34" and raising wash-water troughs 8". After studying and varying details of filter washing, good results were obtained, and better washing than before. There is no evidence of failure of filter heads, clogging of screened section or escape of sand through screen. "The desirability of this system will no doubt be determined by its comparative cost, the difficulty faced by some plants in expanding by the addition of new filters, and whether added capacity by this means is justified at the possible expense of slightly increased effluent turbidity for a short period of time."

Winter filter operation at Winnetka, Ill., was made difficult by ice, which in 1936 was 20" thick at the inlet of the coagulating basins and 22" at the outlet, 4" thick on the rapid sand filters, and 7" at the outlet of the filtered water reservoir. Adjacent to the plant was a municipal power plant with condenser equipment. During freezing weather condenser water was bypassed to the water works intake pipe, thus warming the water; condenser water so used equalling 35% to 80% of the 2 mgd. rate of pumpage to the filtration plant. The ice in the open coagulating basins was gone 72 hours after this was begun, and in the filtered water reservoir 96 hours after. The condenser water was analyzed and found satisfactory for water plant use, but as a precaution the alum dose was increased from 0.8 to 1.1 grains per gal., prechlorination used at 4 lb. per million gallons, and activated carbon at 20 lb.

Slow sand filters were built by Greenfield, Mass., in 1935, with provision for coagulating during occasional short periods of turbidity reaching 150 ppm. or more. Slow rather than rapid sand filters were chosen: (1) Because the filters were on a hillside five miles from town, making constant attendance for washing, etc., difficult. (2) The color of the water is low, a chemical treatment for turbidity is required but about 1% of the time. (3) Treatment of slow sand effluent with chlorine is not required by the State Dept. of Health. (4) Misfits in treatment are less serious in their effects. (5) Difficult disposal of wash water is avoided. The plant is of 2 mgd. capacity; a 2-unit coagulating basin, two 0.2 acre filters, filtered water basin, filter house and appurtenances. During year of operation, alum applied at 12 ppm. three days in January and at 22.2 ppm. two days in March. Filters scraped twice.

A similar plant was built in 1936 in Northborough, Mass., filtering a polluted, highly colored water; chemicals are used continuously but without constant attendance, and "postponement of filter scraping may be made without the serious consequences that would follow failure to wash rapid filters at the proper times."

Methods and Cost Data on a Black Top Road

By LOUIS ROHRMOSER, Supt.
Mason County, Mich., Board of Road Commissioners

THE most interesting job we had this summer was the construction of two pieces, totalling five miles, of black-top road. One of those black-top jobs was two miles in length, twenty feet in width and 2¾ inches in depth.

The roadbed on which we laid this black-top was an old well-travelled gravel road through a prosperous agricultural neighborhood. About a month before we planned on applying the asphalt we added clay to the gravel at edge of road and with a motor grader and maintenance patrol truck mixed the clay into the loose gravel over the surface of the road. Calcium chloride brine was then applied. This then was a well-stabilized road.


Louis Rohrmoser

We next placed 700 yards of gravel to the mile. This gravel tested between 60 and 75% and was of a sand type with no clay content. After we had spread the gravel we applied 12,000 gallons of asphalt (Standard Oil MC-4) to each mile. Gravel and asphalt were then mixed back and forth across the road with a tractor and grader until the mixture was all black and appeared to "crawl." This mixture was laid out to the width of the road, twenty feet. This gave us a depth of 2¾" of material. After the material had been laid out and the road shaped, we rolled it. This had to be done at night after the road had cooled off, to avoid picking up on the wheels of the roller.

After a two-day wait we spread a "fog" coat of the same MC-4 asphalt at the rate of 2,500 gallons to the mile. This completed the road until next year, when we will apply a seal-coat. Traffic was held off the road until the material had set to a certain extent, which was only a day or so.

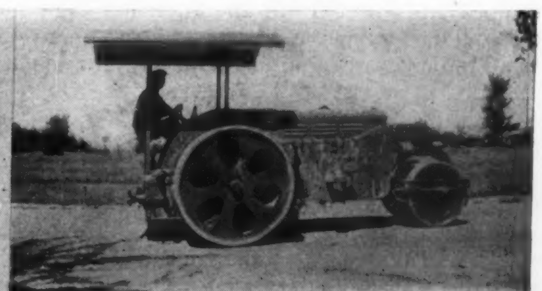
The equipment used was a Simplex distributor, 700 gal. capacity; a 7-ton Huber roller; a Galion motor grader, Model C; a T-40 International tractor; a Caterpillar grader, and an old steam roller used for heating the asphalt in the tank cars. The gravel we produced in our own pit, using a No. 40 Diamond screening plant.

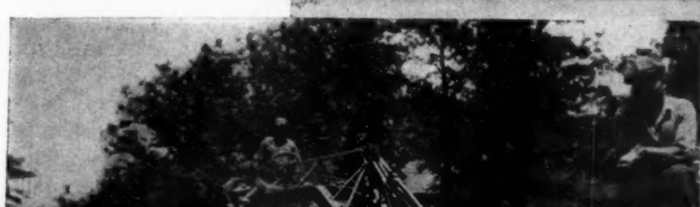
The cost of each mile of this was as follows:

Rentals on equipment	$850.67
Labor	427.63
Gasoline and oil	165.69
Materials	1,255.25
	$2,699.24

So, for a cost of $2,699.24 per mile we have a hard, smooth easily maintained road.

Equipment used on black-top road: Galion motor grader, Huber roller, Caterpillar grader, International tractor and Simplex distributor





Cleaning Heating Coils in a Digestion Tank

By DONALD E. HENN
Superintendent of DeKalb, Ill., Sewage Plant

FOR the last year and a half it has been becoming increasingly evident that the heating coils in the digester were coating with a cake that was insulating the coils and reducing the transfer of heat. During the winter of 1936 and 1937 the temperature in the digester dropped below efficient digesting temperatures, and it became evident that it would be unwise to attempt to face another winter season without attempting to at least return the existing heating coils to their original efficiency.

Considerable thought was given to this problem and a plan developed to drain and repair this unit without interfering with the operation of the plant and to put the digester unit into service again without delay or loss of efficiency. A team was hired to slip out a large shallow hole to the east of the storage tanks as a temporary sludge lagoon, the drying beds were cleaned and the two storage tanks pumped out, and on the 8th of September all was ready to start the work. All sludge in the digester was drawn to the storage tanks and all water and scum to the drying beds. The digester was then pumped full of plant effluent to purge it of gas and this water then drawn to the drying beds where it soon drained through the sand.

An air blower rated at 1200 cu. ft. of air a minute was set over one of the manholes of the digester to blow through a 20 inch pipe to the bottom of it. This gave a theoretical change of air every 18 minutes. This fan was started on the afternoon of September 11 and ran continuously for 40 hours before any attempt was made to enter the tank. The fan was run continuously until the work was completed.

Monday, September 13th, several sparrows were trapped and lowered into the tank in a cage and left there all day without any adverse effects, and were used as an indicator of condition of the air in the bottom of the unit.

The only unforeseen difficulty arose Monday A. M. when it was discovered that one of the scum breaker arms was bent very badly. After a hurried conference it was decided to remove both scum breaker arms as it was agreed that the real scum arms were in the bottom of the tank. The removal of the arms made it necessary to construct staging in the tank, cut the arms out, and then remove the staging in sections. This work required three days to complete. Thursday, September 16th, work was started on cleaning the cake off the existing heating coils and the installation of a new coil. The cake on the existing coils averaged ⅝ of an inch thick and was made up of very definite laminate layers. No difficulty was experienced in breaking this cake off of the pipes, less than 8 man hours being required to clean 380 ft. of 1¼ inch pipe.

The existing heating coil in the digester consisted of three 1¼" pipes hung on the wall of the round tank, each pipe being 125 ft. long, starting and ending in a header. A connection was made in the pipe from the return header and one 2" pipe connected to it and carried around the digester and back to the return pipe to the heating unit in the office. Thus, all hot water pumped through the heating unit will circle the digester first through one of the 1¼ inch pipes and then a second time through the 2 inch pipe. It is estimated that this will increase the heating capacity by about one half. This additional heating pipe was installed for two reasons —one immediate, the other permanent. Previously the average temperature in the digester could be raised only about 2 degrees a week in mild weather, held constant in cold weather, with a loss of temperature during the severe months of the winter. Then it was necessary to start the winter with high digester temperatures in order to have digesting temperatures above 70° F. by spring. It was also necessary to carry high temperatures in the heating coils, which added to the caking with the resultant loss in heat transfer. Because it was necessary to do this work in the fall, making necessary the filling of the digester with relatively cold water late in September, it was evident that with the existing heating unit a sufficiently high temperature could not be obtained in the digester before cold weather to carry over until spring. With the additional heating coil it was hoped the temperature could be raised more rapidly and then maintained. The second and more important reason for the addition was that much lower temperatures can now be carried in the heating coils with the resultant reduction in caking of sludge on the heating pipes.

At 10:30 A. M. on September 17th. just 9 days after work was started, the work was completed and the sludge pump started pumping seed sludge to the digester.

During the time the digester was out of service all raw sludge was pumped to the storage tanks which had been well seeded with sludge from the digester. When work on the digester was completed, digesting sludge from the tanks was pumped to the digester, raw sludge added to it and filled with plant effluent. The digester was full at 8 A. M. September 19th and was producing gas at the rate of 142 cu. ft. per hour, which increased gradually to 384 cu. ft. per hour, or 9200 cu. ft. per day, by September 23rd. The temperature of the sludge on September 19th was 73, the pH 6.8, and volatile matter in seed sludge 46% of dry solids. The heater and circulating pump was started on September 19th and by October 2nd the temperature of the sludge had raised to 87° F., the average temperature to 84.4° F. and the pH to 7.0 without the addition of lime, and the digester had settled down to normal operation.

This rather difficult and dangerous work was completed without an accident of any kind to either man or equipment and without loss of efficiency of the plant itself. Two laborers were hired to assist the regular plant personnel of superintendent (Don Henn) and assistant (Herb Snider).

The above is an extract from Superintendent Henn's September report to the Division of Sanitary Engineering of the Illinois Dept. of Public Health, as it appears in "The Digester," the quarterly publication of the Division. Commenting on it, the editor of "The Digester" says: "This fellow Henn is certainly no cluck!"

Planning Location of Underground Utilities

Abstract of a Manual on the subject prepared by a committee of the American Society of Civil Engineers.

SINCE 1931 a committee of the City Planning Division of the American Society of Civil Engineers has been preparing a manual on Location of Underground Utilities, and their results have now been approved and published by the Society as Manual of Engineering Practice No. 14. This brief (12-page) manual is divided into three general parts—General principles of organization; Standards for recording and office practice; and General standards of design. The following abstract gives an idea of the manual.

"Underground planning is seriously limited by the restraining influence of existing underground utilities; and yet, in every city and in every region, a beginning should be made to prevent the recurrence of haphazard allocation of space beneath thoroughfares for the locations of all types of underground construction. In places where the importance of intelligent underground planning has been recognized, certain general principles of that subdivision of city planning have also been recognized, developed and applied. To aid others in this undeveloped field of planning, eleven general principles are offered as a guide to good organization."

Briefly these principles are: Plans for location of underground utilities should be developed as an adjunct of every city or regional plan, by an official agency affiliated with the regular engineering staff, which agency may be a special department or a division of the regular city engineering organization. Its work should be aided by a co-ordinating committee including a member of the city or regional planning authority, and engineers in charge of paving, sewers and water distribution and of underground distribution for gas, steam, refrigeration, electric light and power, telephone and telegraph and the transit companies, and a few consulting engineers practicing in that area.

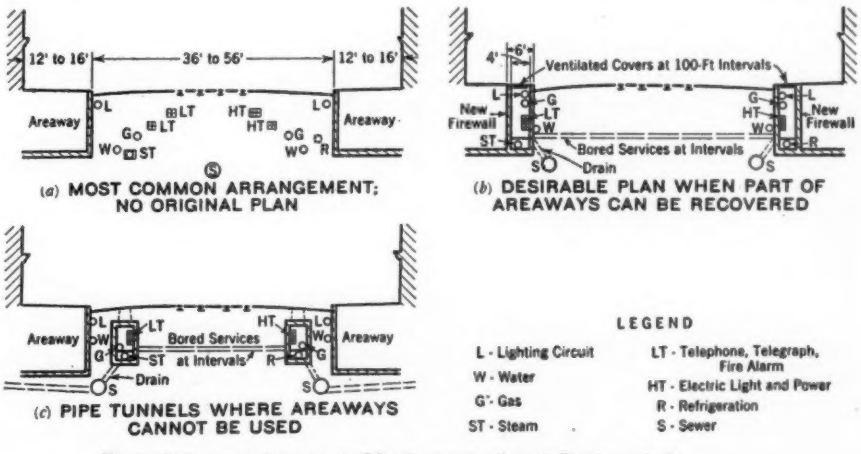
The underground plans should include records of all existing underground utilities and recommendations for all future extensions of them, relocations, enlargements and additions. The work of the agency should be closely correlated with the other features of city and regional planning. Standards should be prepared for all maps, detail sheets, street intersection plats and master control plans; for sheets for recording new construction; street cross-sections depicting recommended locations for utilities, with manholes, vaults and tunnels; methods of tapping utilities and of replacing street paving, and permit forms for underground construction.

Plans should be developed to provide for at least five future years, to be revised from time to time, well in advance of any paving. The work of the agency should be correlated with that of all construction agencies, so that records of underground utilities may be kept complete and up to date, and street openings, interruptions to traffic and costs of installations may be minimized. Unnecessary openings should be discouraged, as by showing advantages of tunneling or other alternatives. The agency should have power to assign definite locations to each utility and to compel conformity thereto. If not financed directly by the municipality, it may be by charges for permits, inspections, copies of records, etc.

The basis of the underground plan must be a good set of maps of the streets and record of existing services. Detail sheets should have a scale at least as generous as 1 in. = 20 ft., or perhaps smaller for outlying sections. In general, there should be a master plan for each type of underground utility, (a scale of 1 in. = 200 ft. is suitable) all proposed features of which should appear on the detail sheets. Intersection plats (1 in. = 10 ft.) are desirable, as well as complete street plats. In many cases profiles should be prepared showing elevations of all utilities. The detailed sheets should show all manholes, vaults, tunnels, and private coal holes, vaults, gratings, fuel-oil tanks etc.; and be cross-referenced to field books or sketches showing locating dimensions.

Tunneling is apparently favored by the committee, which says: "The use of pneumatic tools has made tunneling operations much more economical than formerly, but utility companies and city departments are usually loth to dig tunnels if they can possibly work in open cut." Also, concerning the construction of permanent tunnels it says: "In many cases this will facilitate access to the utilities, simplify enlargement of such services, prevent unnecessary investments in cable, pipe, etc., prevent breakage of conduit and pipe, eliminate destruction of pavements for work in connection with underground utilities, and eliminate interruptions to traffic caused by work on underground utilities installed in the usual manner."

Providing for future installation of certain utilities in



Typical street section, central business section of Cincinnati, O.

the space now entirely reserved for sidewalks and parkways may offer several advantages, such as reduced cost, opportunity to reconstruct old walks at no additional expense, and eliminating cutting into roadway paving. Where there are alleys, these offer similar advantages. Many other suggestions are offered in the manual, including a number of typical arrangements of utilities in both business and suburban sections.

Uniform Velocity Grit Chamber

THE Mogden (West Middlesex, England) sewage treatment works serve a population of 1,100,000 people and are closely surrounded by a good-class urban development. It was therefore necessary to eliminate the customary detritus dump or reduce it to a minimum of size and offensiveness. To effect this, disintegrators were installed to do away with the screenings problem (about 500 cu. ft. of screenings per day is handled), leaving the elimination of organic matter from the grit to be obtained by either preventing its settling in the grit chamber, or washing it out of the grit after settling. The latter is the more common modern practice, displacing the former because of the unsolved problem of maintaining a uniform velocity of flow with a wide range of volume.

The maximum discharge at the Mogden plant reaches 575 mgd, and the range from night dry-weather flow to storm flow is nearly 1:30. The problem of maintaining a uniform rate of 1.00 ft. per second through a grit chamber or set of chambers would therefore seem to be a difficult one, but is said to have been solved by a plan described by C. B. Townsend, engineer in charge of the plant, in a paper before the Institute of Sewage Purification. The Mogden grit chamber he calls a "flume-controlled chamber," and describes it as follows:

In recent years, as a means of gauging the flow of sewage to the purification works, the weir has given place to the Venturi flume, which possesses certain outstanding advantages over its rival, not the least being the large reduction in loss of head involved.

When such a flume is of the standing-wave type, so often adopted, it possesses the characteristic of producing a fixed upstream depth of water for a given flow irrespective of the down-stream conditions, subject always to the flume not being converted into the "drowned" type by the backing up of the down-stream level beyond a certain critical depth.

If, therefore, the flume which would be normally installed for recording the flow to the works is located immediately below the grit chamber, the flume will control the depth of flow in the chamber at a definite level corresponding with the particular volume being discharged. Moreover, if the grit chamber can be designed to follow the law of the flume in such a manner that the cross-sectional area of the chamber at any level is proportional to the volume of flow through the flume at the same level, then it is possible to maintain in the chamber any given velocity of flow stipulated.

Each of the chambers in a multiple unit system, therefore, may be controlled by its own flume. Alternatively, such a system may be divided into groups of two, three or more chambers, each group being controlled by one flume. Other combinations involving chambers of unequal size are possible to deal with special conditions in almost infinite variety, always provided that the characteristics of flumes and chambers are designed in accordance with the formula.

The advantages of the multiple unit system are obvious. In times of dry weather, it is only necessary to operate a minimum number of chambers, in most cases one unit being ample for the purpose. This makes possible the throwing out of commission most of the plant under normal conditions, thereby giving ample opportunity for adequate maintenance of the installation and obviating the necessity for special standby units. Again, the flow being confined under these conditions to one portion of the plant, very shallow depths are avoided at the time of minimum flow, and further, the work of grit removal is greatly simplified.

Since it is just as important to remove grit from the sludge derived from storm water as it is from normal sludge, particularly where digestion plants are subsequently involved, it is very necessary to subject all storm water to such preliminary treatment. With the multiple unit system, it is possible to design a battery of grit chambers sufficient in capacity to take the maximum flow to the works including all storm water. The storm-water weir or other separating device may be placed above the grit chambers in such a manner that flows above three dry-weather flow are treated in certain units specially reserved for storm water or, alternatively, separation may take place below the chambers after the entire flow has passed through them.

The Mogden chamber is divided into twelve equal units, each with a parabolic width of 15 ft., operating in pairs each controlled by one of six flumes. The length of chamber is 90 ft., giving a detention period of 1½ minutes, sufficient to enable a particle to fall through the depth of 9 ft. at a velocity of 0.1 ft. per second. The cross-section is a modified parabola, with the flatter part near the invert sloped not less than 45° to concentrate the grit at the center for easy removal. In addition, a trough is constructed in the bottom to provide a grit storage space of 15 cu.yds. per channel, which is dredged by pumping often enough to prevent the grit encroaching on the flow channel. The pumped grit is washed, the wash water being returned to the grit chambers, and then averages 97.5% mineral matter.

The velocity of 1.0 ft. per second can be maintained continuously over the entire 1:30 range of flow, irrespective of the number of chambers in use. When any sudden change of conditions occurs, such as the bringing of an additional chamber into use, the flow to each chamber is equally suddenly reduced, but the controlling flume immediately takes charge and lowers the water level to the correct depth, the velocity of flow remaining unchanged. The arrangement in this respect is fool-proof.

The cost item is another advantage. The grit chamber has a capacity less than one-sixth of that of the standard detritus tank and, although the type may be more expensive per cubic yard to construct, the total cost is very much less. The amount of detritus handled is reduced enormously and the cost of pumping it is insignificant. The cost of land for the detritus dump is eliminated.

Cost of Bridge on County Line Highway

A bridge was constructed on a county line highway under the direction of the Kansas State Highway Commission after the county commissioners of the respective counties had failed to agree upon its construction. The Kansas Supreme Court held (State v. Board of Com'rs of Kearny County, *72* [2d.] *67*) that a county which refused to pay its share of the bridge could be compelled by mandamus to do so, although the bridge, because of engineering difficulties, was located in the other county 2,050 feet from the line.

The Editor's Page

Making Money Out of Roads

Here is a little mathematics that should be of interest to our readers. If a road has a traffic of 700 vehicles per day, how much will it yield through gasoline taxes alone? Well, it is quite a surprising sum. Let's do some figuring (for deeper mathematics, see page 7). If the drivers get 15 miles to the gallon (which most of them don't); and the gasoline tax averages 5 cents a gallon (which it does—actually slightly more); then the 700 cars a day will burn a little less than 17,000 gallons per mile of road per year; and the income from gasoline taxes will amount to about $850 per mile.

With modern types of surfacing, properly built, and designed for the traffic that they will have to carry, a few miles of road would be a pretty good investment. As a matter of fact, good roads *are* a good investment, as the nation has found out most conclusively.

Suggestions to Cities with High Taxes

It used to be said that we in this country were not tax conscious—most of our federal taxes were indirect and our local ones were low compared to other countries. But no longer! With taxes taking 20 per cent of the total earnings and applied to everything from real estate to cigarettes and every purchase over 10 cents, every one knows about taxes.

One aggravating feature is that a large part of them is to pay for a "dead horse"—money already spent. Interest and sinking funds for outstanding bonds are a "must" item in most city, state and federal budgets which looms big in far too many cases. Yet we go on piling up more such charges by issuing more bonds and so increasing the tax burden for the years to come.

Many but not all do this. Kalamazoo, Mich., in 1918 had a bonded indebtedness of nearly half a million dollars. Last November it paid off its last bond; and in the mean time it has built a new city hall, a million dollars' worth of pavements and sewers and several bridges, has motorized its fire department, purchased and improved large park sites, acquired a 300-acre airport, two municipal golf courses and several playgrounds, made extensive additions to its lighting plant and water works and purchased an asphalt plant. All has been done on the "pay as you go" plan and at the same time the debt has been paid off that was accumulated by the former "the future be damned" policy.

There are not many cities that have had the backbone to adopt—and adhere to—the "pay as you go" plan. Taxes are too unpopular with voters and bond issuing too easy. If only that plan could be followed and at the same time taxes reduced! Well, can't they?

Taxpayers have often been told, but still fail to realize, that a large part of their taxes go for the performance of special services—sewerage, street paving and cleaning and lighting, refuse collection, water supply, fire protection and others. If they went only for the expenses of government proper, even with the large demands of public schools added, taxes could be reduced materially. But how to pay for these utilities? The answer is at hand—has been applied in a number of cases. Many water departments are entirely self-supporting—make them all so. Several municipalities are financing their sewerage systems by sewer rates; changes in a few state laws would permit all to do so. Street maintenance and cleaning could be paid for by street users, through vehicle licenses. Several cities charge for refuse collection by collecting rates from the householders served.

Money collected for these purposes as rates for special services rather than as an unrealized part of the general taxes would, we believe, be paid with less protest, even though the sum of all of them plus the taxes should total no less than the taxes under the present plan. But we believe the total would be less. When the manager of a utility knows that failure to operate it economically means an increase of rates to all the citizens instead of an increased allowance by a budget committee, he is going to be more careful about his expenditures.

These are suggestions. We hope they will be helpful to some cities who find themselves sinking ever deeper in a financial quagmire; to some officials who are honestly and earnestly concerned to help their cities out of it. Some cities have done all these things; others can do them if they will.

Power Development Ownership and Source

There has been much discussion lately about the relative merits of public and private ownership of electrical utilities. A few figures from the Federal Power Commission and other sources may be of interest. In 1907, municipal utilities generated 4.9% of the power developed, and private utilities 95.1%; how about 1936? In that year, the percentages were 4.7 and 95.3, respectively. The *proportion* of power developed by publicly owned plants has not increased, even though the amount of power has increased some twenty times in each case. The relative position has not changed.

In 1919, 37.5% of all power developed was derived from falling water, and 62.5% from fuel. Seventeen years later, with some three times as much power being developed annually, the percentages were 36.0 and 64.0. Of the power developed from fuel in 1936, 81% was from coal, 12% from natural gas, 6.5% from fuel oil and 0.5% from wood. This, naturally, does not include the power generated by some twenty-five million automobile engines, but refers only to electrical power for homes and industry.

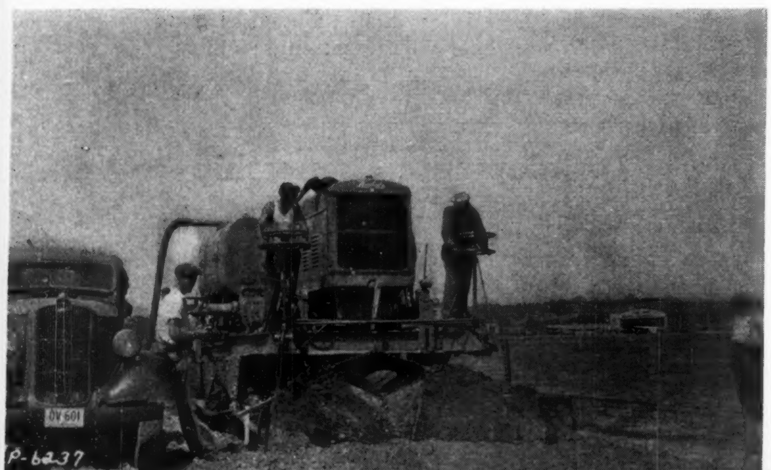
Building roads in Ohio: Left, spreading 132 lbs. of ¾" to ¼" stone per yard to a width of 8' to permit easy pickup by the mixing unit. Right: Applying 1.1 gals. bituminous material per sq. yd. Spreader in background.

Road Mix Construction by Portable Plant

Data and Photographs by Lion Gardiner
Vice President, Jaeger Machine Co.

TRAVELING plants for road-mix construction have shown very definite progress in the past three years. Plants may be classified as (1) for light retread or road-mix work and (2) for heavy mat and stabilized base construction; or for both of these.

Ohio has done 400 miles of resurfacing work, much of it on old brick, concrete and macadam roads, laying 1½" retread sealed with 15 lbs. of chips, giving an excellent riding surface. On the road shown in the photographs, stone aggregate graded from ¾" to ¼" was spread to a width of 8 ft. to be picked up by the mixing unit. Following this, RC-3 cutback was applied at the rate of 1.1 gal. per sq. yd., and a spreader then added approximately 10% by weight of fine aggregate, such as screenings or concrete sand to choke the mix. A tractor-drawn pugmill followed immediately, picking up the aggregate and mixing it and returning it to the road. At the rear is a strike-off supported by two 21 ft. long straight-edge runners which strikes off the material ready for rolling, this method of supporting the strike-off blade securing a uniform surface. This machine can be drawn by either a large, heavy tractor with a rear axle reduction, or by two medium weight units, at a speed of 40 to 50 ft. per hour. Rolling followed immediately after placing. In laying the second lane the procedure was the same, but a blade on the mixing unit



Mix-in-place work on the Akron airport, where 130,000 sq. yds. of emulsion stabilized paving were placed in 1937. Top view shows a Jaeger machine grading and stabilizing material for a 4-in. compacted base using 2½ gals. per sq. yd. of emulsion. Water is added to supply necessary moisture. After 24 to 48 hours, the material is compacted with a Sheepsfoot roller, then with a rubber tired roller and finally with a standard roller.

Lower picture shows emulsion tank at right: hose in foreground supplies the extra water—2 to 3 gallons per square yard, depending on moisture content of aggregate. Average gradation of the material on this airport job was 25% gravel, 2-in. to ¼-in.; 50% well graded sand and remainder material passing 200-mesh, at least one-third of which was colloidal clay.

Left, a rear view of Jaeger mixer showing materials spread ready for roller. Block-off plate shows how 9-ft. width is spread. Right, the rolling operation following immediately behind mix-in-place machines.

cut off 4 to 6 in. of the first lane so as to leave a straight vertical edge of well compacted material for the joint. This two-lane construction with immediate rolling eliminates the necessity for detours, and the heavier cut-back that is used eliminates the throwing of loose material by their wheels onto the bodies of any cars that may drive over it during construction. It is said that this machine—a Jaeger triple pugmill—can lay in a ten-hour day 1,000 tons of aggregate, sufficient for approximately three miles of 9 ft. to 10 ft. strip. A final seal coat is usually added within a week after construction.

The highway maintenance department of Oklahoma uses the same machine for mixing aggregates of a gradation such that 100% passes the ¾ mesh, and 50% to 90% the 10-mesh, about 7% by weight of an inverted emulsion being used. The thickness of the mat varies from 1½ to 2″. Due to the gradation of the material, two passes of the mixing machine are made, one-half the bitumen being added at each pass. With the use of the inverted emulsion it is possible to obtain good results even with a moisture content of 2% or 3%. In summer the mix is not rolled until two to four hours have elapsed, but in colder weather the rolling is done immediately. A seal coat is applied 3 to 6 months after construction, using 0.2 gal. of inverted emulsion per square yard, with a light application of coarse sand. Approximately one mile of 22 ft. road a day is built.

A heavier self-propelled type of machine is used on stabilization work, mixing sand-clay-gravel base, airport stabilization with emulsions, down to the fine mixes such as the sand-asphalt stabilization of the South.

To assure uniform application of binder in this work, the aggregate is spread accurately through a suitable spreader box or the windrow made uniform by drawing a windrow evener over it, and rate of application of the binder is regulated by use of tachometers indicating the forward speed of the machine and the revolutions of the metering pump driven by a separate engine with micro-governor control.

In laying 130,000 sq. yd. of runway paving at the Akron, O., airport in 1937, the same equipment was used for mixing and laying stabilizing material for a 4″ compacted base, using 2.5 gal. of emulsion per square yard. The ground was scarified and clay and gravel added to make up the deficiencies, the gradation of the aggregate being 25% 2″ to ¼″ gravel, 50% well-graded sand, and 25% materials passing the 200-mesh, at least one-third of which was colloidal clay. While mixing the material, water was added in the pugmill so that the mixture, as it was laid, contained moisture somewhat beyond the optimum required for maximum compaction. About 24 to 48 hours later the material was rolled with a sheep's-foot roller, followed by rubber tired rollers and these by an iron roller for final surfacing.

Left, mixing plant on sand-clay gravel stabilized base 22 ft. wide, built in two 3-inch lifts and in two 11-ft. lanes. Water tank in rear. One pound of calcium chloride per square yard is placed in upper 3-in. layer. Speed of mixer 17 ft. per min. Work by Mid-Continent Engr. Co., Chicago, job at Peoria. Right, a sand asphalt stabilization job in South Carolina: 22-ft. wide; 5-in. compacted thickness; 3½ gals. per sq. yd. RC-3. Material all passed 50-mesh, and 10% to 15% passed 200-mesh.


Important Details in Stabilization With Calcium Chloride

By B. C. TINEY
Engineering Division, Calcium Chloride Association

THE trend of design of stabilized mixtures of aggregate, binder-soil and calcium chloride has been to reduce the proportion of binder-soil and thereby lower the plasticity index of the mixture. A study correlating the wet-weather behavior of stabilized surfaces with their plasticity indices has indicated the desirability of somewhat lower binder-soil content.

Stabilized mats which are being constructed as bases for bituminous surfaces to be placed within a short time, are being designed with lower plasticity index than mats which will have direct traffic wear. This permits better penetration of the prime coat of bitumen and guards against lubrication of the granular particles and consequent rutting or failure which might happen with excessive plasticity when wet. The presence of calcium chloride in these less cohesive mixtures increases and sustains the moisture bond to supplement the reduced soil cohesion.

Stabilization specifications of the Calcium Chloride Association, which formerly provided a plasticity index range of 4 to 12 have been revised to a range of 1 to 9, with provision for a maximum of 6 in bases that are to be covered within a year.

Greater emphasis is now being placed on the importance of having the optimum moisture content in a mixture in order to secure the maximum density with given compactive effort.

The service behavior of stabilized mats of varying thickness is being studied on an extensive research project in Minnesota, the Bureau of Public Roads cooperating with the State Highway Department.

A sub-committee has been organized in the American Society for Testing Materials to develop tests for stabilized soil aggregates. It becomes increasingly important to be able to determine the quantitative values for stability which will permit designing stabilized mats of maximum strength and of gauging the necessary thickness according to the bearing power of the subgrade. The Engineering Division of the Calcium Chloride Association is now making field investigations of the applicability of shear tests as a measure of mat and sub-grade stability.

The past year has witnessed a notable increase in plant production of stabilized mixtures. The construction of stabilized wearing courses and bases has definitely entered the contract field and a number of states have preferred or actually require plant mixing in these contracts. Both stationary and traveling plants have been used and a number of equipment manufacturers have designed and built new equipment for this field.

The pug-mill or continuous type of mixer has been most commonly employed. Aggregates and binder-soil are fed into the pug-mill in continuous flow by belt conveyors. Proportioning is accomplished by adjustment of belt speeds and the size of openings in bins that feed the belts. An automatic feeding device provides feeds of flake calcium chloride from hopper to belt or pug-mill.

Preliminary pulverizing of the binder-soil is usually accomplished by a roll-crusher and in one case by wet-mixing in a pug-mill.

Batch-mixing with standard concrete mixers has been practiced on a number of projects and one manufacturer of clay-processing machinery has designed a special batch-mixer for stabilization materials. Greater accuracy in proportioning is possible with a batch-mixer.

The Michigan State Highway Department in a recent large purchase of gravel for maintenance resurfacing has specified pre-stabilized mixture including calcium chloride. It is predicted that the time is not far distant when the use of pre-stabilized gravel, stone and slag will be common practice in the resurfacing of traffic-bound roads. Modern traffic does not tolerate a condition of loose aggregate on road surfaces and the waste of good material resulting from lack of bond is becoming increasingly apparent to many engineers. Pre-stabilized surfacing material, due to the presence of binder-soil and to proper moisture content sustained by calcium chloride, compacts quickly and more densely under traffic.

It is anticipated that manufacturers of screening and crushing equipment will recognize this growing field by building stabilizing equipment into the same unit with crusher and screens.

In the compaction of stabilized courses there has been an increased use of the multiple-wheel pneumatic tired roller, to accomplish full depth compaction. The sheepsfoot roller is being used on some projects and smooth-faced rollers are used in multiple course construction and to finish the surface.

An important development of 1937 has been the increased maintenance practice of consolidating the loose surface material on gravel and stone roads by the addition of binder-soil and calcium chloride. This practice utilizes the principles of soil stabilization in a non-technical way and accomplishes outstanding improvement in surface condition. It points to an extensive field of partial stabilization where exact design and laboratory control are not practicable.

This method involves the addition of a trial amount of soil, which in many cases may be obtained by scraping from the shoulders. If the shoulder soil does not have good cohesive properties, a suitable clay soil is hauled and spread. After the pulverized soil has been thoroughly blade-mixed with the loose aggregate, it is spread, watered (by sprinkling tank or rain) and treated with a surface application of calcium chloride. This combination compacts rapidly under traffic and remains in a bonded and dustless condition.

If the surface becomes slightly muddy after the first heavy rains, an excess of binder-soil is indicated and is corrected by spreading a small amount of sand, or fine graded aggregate. If raveling of the surface occurs in dry weather, a small amount of additional binder-soil is bladed into the surface. Behavior under traffic in both wet and dry weather is thus made the very simple and practical criterion by which the maintenance superintendent establishes the proper balance between the soil and aggregate. Experience with his local materials soon enables him to judge this so well that the amount of correction required is very small.


Left: The process of making a good road and, right, a surface treated highway.

Surface Treatment With Tar

by A. R. TAYLOR
Consulting Engineer, Tarmac Dept., Koppers Company

SURFACE treatments are widely used and many of them are giving satisfactory service after 15 years or more of use. The success of these treatments has been due largely to their being placed originally over adequate bases and in properly maintaining the surface, including retreatments at proper intervals.

Despite this wide use of surface treatments there is probably no type of surfacing wherein less attention has been paid to construction methods. This has been largely due to the fact that surface treatment work has been considered a maintenance problem and, moreover, one so simple as to require little study or attention. Proper attention given to drainage, base construction and to the details of the surface treatment itself, such as the selection of the proper grade and amount of tar, and size, gradation and amount of aggregate and their methods of application, will pay dividends.

Important Factors in Good Work

Probably the most important factor in obtaining satisfactory results from surface treatment work lies in the construction of adequate bases to handle traffic requirements. The depth of the base course required depends, to a large extent, upon the drainage and the nature of the sub-grade. Proper drainage is essential, particularly for the thin wearing surfaces that are obtained with surface treatments. Heavier base courses naturally are required for poorly-drained sub-grades than for well-drained sub-grades.

In the long run it is cheaper to confine surface treatments to stable base courses. Certainly where local gravel, slag, stone and suitable soils are plentiful and cheap it is poor economy to try to reduce costs by cutting down the depth of the base in order to save one or two inches of aggregate. The additional depth is a sound investment, as it assures satisfactory results from the surface treatment and greatly reduces maintenance.

Insufficient attention is often paid to the proper consolidation of top soil and gravel bases. It is frequently felt that if traffic is allowed to use such bases for a month or two they are sufficiently compacted to receive a surface treatment. In many cases this is not true and it is not uncommon to find that undue settlement and weak spots develop in the base course. If the road has been surface treated before these failures occur, the surface treatment is often unjustly blamed.

In some localities suitable aggregates are both scarce and expensive to use. In such cases, adequate bases may be provided by stabilizing the existing sub-grade material by mixing the soil with water and tar and compacting it to the maximum density. Sometimes it may be more economical to add aggregate before mixing it with water and tar; but in either case it should be kept in mind that the stabilized base course should be constructed to a sufficient depth to provide support for traffic loads.

The base course construction determines the type of surface treatment which should be used. Ordinarily the double cold and hot surface treatment will give the most satisfactory results for surfacing newly constructed bases, or old base courses which have been reshaped. This type of treatment combines the advantages obtained from the use of both the cold and hot application tar. The prime coat may be varied so as to take care of either a tight or an open and porous base course. If the base course, after compaction, has a thin layer of loose aggregate on the surface, this aggregate may be tied down by applying a heavy prime coat. Ordinarily for this purpose it will require from .4 to .6 gal. of tar prime. For tight bases, a prime coat of .25 to .30 gal. is sufficient. The prime coat is followed by an application of hot tar, which builds up a reasonably thick and resilient wearing surface, which does not crack or break if slight deformation or settlements occur in the base. The self-healing action of the tar will usually correct such minor cracks as do occur. The use of hot rather than cold application tar in the second application permits the use of larger sized aggregate and thus builds up a thicker wearing surface for the same quantity of bituminous material.

There is an increased tendency to apply a seal coat over the double surface treatment, as it permits the use

of still larger sized aggregate for the surface treatment. The seal coat of tar and fine aggregate, by filling the voids of the coarse aggregate used for the surface treatment, gives a tight dense wearing surface. It is not unusual for these to carry traffic satisfactorily for periods of 4 to 6 years before requiring any retreatment.

Cold application surface treatments may be used to advantage under certain conditions, as where it is necessary to use very fine graded aggregate as cover material. In such cases the saving in the cost of the aggregate warrants the use of this type of treatment.

One recent variation in the type of seal coat deserves attention. It consists of replacing the liquid seal with a mixture of fine aggregate and tar. Usually this is mixed in small portable plants adjacent to the project. After the surface treatment has been tack coated with .1 gallon of tar, the mix is spread at the rate of 30-50 lbs. per sq. yd. by means of blade graders or mechanical spreaders, and then rolled. In some cases the mixture is given a light .1 gallon seal coat and sanded. This type of seal coat has not been in use a sufficient length of time to determine whether the extra expense involved is warranted, but results indicate that an application of 40 to 50 lbs. per sq. yd. results in a uniform surface.

Retreating Old Surfaces

Probably the widest use for surface treatment work is for retreating and sealing old bituminous road surfaces. Retreatments are applied primarily to seal the road surface, to build up the wearing course and improve the riding qualities of the old surface, or to make slippery surfaces skid-resistant. For these purposes either heavy cold application or hot application tar is used successfully. The trend has been toward the use of hot tar for sealing open surfaces, or where it is desired to build up the wearing surface; and cold application tar for sealing tight or dry surfaces. Hot tars hold a greater amount of cover material than do cold application tars. Being of heavier consistency hot tars are covered with larger sized cover material. Open or porous road surfaces require heavier applications than do tight surfaces. Where the surface is porous the tar penetrates into the old pavement, leaving less on the surface to bind the cover material, unless heavier applications are made.

Many retreatments used for seal coat purposes have been used to level or improve the riding qualities of the old pavement. On such treatments, indiscriminate dragging with long base drags has become too prevalent with the result that open surfaces are obtained which do not stand up properly under the high speed traffic of today. Dragging light retreatments using 15 to 30 lbs. of cover material does little towards smoothing up a road surface, as this quantity of cover material is insufficient for leveling purposes. At the same time this practice tends to coat the aggregate with too thin a film of bituminous material, so that the sealing action of the treatment is partly destroyed and an additional seal coat has to be applied in a short time to prevent raveling.

On light retreatment or seal coat work a light broom drag is an effective method for distributing the cover material evenly, and to take up excess tar that flows to the low spotss. When it is desired to improve the riding qualities of a road surface a drag treatment should be applied. This type of treatment consists of mixing 50 or 60 lbs. of aggregate and tar with a heavy drag or maintainer. After the mix has been spread and compacted a light seal coat is applied and covered with fine aggregate to give a tight, dense, skid-resistant surface.

In drag treatments it is important to see that the proper size of aggregate is used. Care should be taken to see that the maximum size of aggregate used in the drag leveling course is not greater than that of the compacted depth of the surface. When this matter is overlooked an undue amount of crushing of the aggregate takes place.

Satisfactory results at minimum cost are obtained from surface treatment work provided that treatments are applied only to bases that are adequate and well drained, and that the proper grades and quantities of bituminous material and aggregate are used for the surface treatment. When these items are overlooked it simply means that the surface treatment will require an unnecessary amount of maintenance and that the wearing surface will have to be retreated at shorter intervals. Attention to these details in construction will be well repaid.

Selecting Surfacings According to Traffic Load

The selection of a type of surfacing which is not capable of supporting the average traffic load necessarily results either in complete failure of the surfacing, or in excessively heavy maintenance costs. The unification of the German road system has rendered possible the collection of valuable data regarding costs of road maintenance, and the correlation of such data with traffic returns. The results of this correlation, though still only approximate, are considered likely to be of use to road constructors in the near future, and a tabulated summary gives the permissible daily tonnage of horse drawn vehicles, motor lorries, and private cars, with the average and maximum values of the total permissible daily traffic load, for a variety of surfacings. These include sandbound macadam (both plain and surface treated), cement-bound and trass-bound macadam, penetration surfacings, asphaltic and tar concrete, mastic asphalt, cement concrete, and small and large setts. The estimated maximum (economic) tonnage for sand-bound macadam, penetration macadam, asphaltic concrete, and cement concrete is respectively 400, 1,350, 3,500 and 6,000 tons daily; the tonnage of lorry traffic which can be carried by small sett paving is 3,400 tons daily; no upper limit is assigned to the tonnage of ordinary motor vehicles. No limits are indicated for any form of traffic on roads paved with large setts, the use of which is recommended for the heaviest and densest traffic of all types. C. GROSSJOHANN: *Strasse, Road Abstracts.*

Controlling Ice in Cleveland

(Continued from page 9)

50 different routes are required during the worst snow and sleet storms. The garage superintendents supervise the activities of the crews, and the man in charge of each truck directs the work of those with him. In very bad weather, every available man is used for snow and ice removal even to the extent of drafting men from other organizations such as garbage collection.

The ice control organization cannot be expected to find dangerous spots not located on their regular routes. Weather conditions frequently change after the regular crews have made their rounds, permitting untreated icy surfaces to exist in various parts of the city. Notices of such conditions are reported to the different garages by police, storekeepers, taxi companies, residents, newspaper organizations and others. These are grouped together according to districts. Unusual emergencies are handled by a special truck.

Soil Stabilization With Emulsified Asphalt

C. L. McKESSON*

ALTHOUGH relatively unheard of four or five years ago "stabilization" is now probably the most discussed subject at every paving conference. It is a term now applied to so many methods of treatment and types of construction that a few words seem justified in an attempt to clarify its meaning as used in this article and to differentiate stabilization with emulsified asphalt from some of the other much discussed types.

A stabilized gravel base is a base in which resistance to displacement under traffic is sought by careful grading of aggregate with the addition of controlled amounts of selected clay. Stabilization with chemical salts usually refers to a similar carefully graded gravel or crushed rock base to which deliquescent or partially deliquescent salts are added.

Stabilization with emulsified asphalt is of an entirely different type. It has three definite objectives:

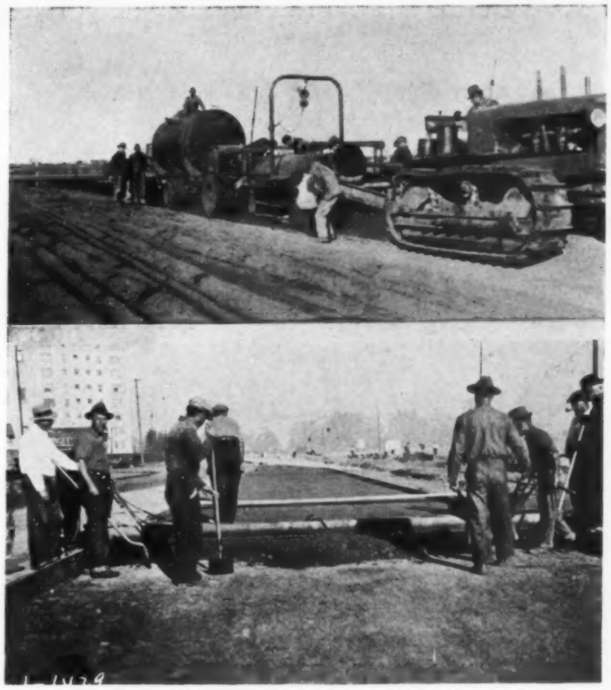
1. Waterproofing the individual soil particles and thereby rendering the base highly resistant to water which would otherwise be absorbed by capillarity.
2. Forming on the soil particles an adsorbed film of hard asphalt, of almost infinitesimal thickness to give high frictional resistance.
3. Obtaining supporting strength in the finished pavement slab by preserving the naturally high cementitious (dry) strength of the clay even when the pavement is subjected to long continued exposure to water.

Emulsified asphalt stabilized slabs have great elasticity and, as a result, slabs even as little as 4 inches in thickness, have successfully carried truck traffic over saturated clay subgrades without shearing or cracking. Under such conditions the slab deflects under the wheel load (sometimes nearly an inch), thus distributing the load several feet in each direction until the concentration is within the supporting strength of the soft clay subgrade.

In emulsified asphalt stabilization, the grading of aggregate to secure stability is not essential and if aggregate is added to the soil it is as an economy rather than of necessity.

Theory of Stabilization

In stabilization with emulsified asphalt it is necessary that the absorbed film of asphalt cover the individual particles, many of which are less than 1/25,000 of an inch in diameter. It is necessary that this film be thick enough to waterproof the soil particle, but not thick enough to destroy the natural affinity of the particles for each other; in other words, the film must not be thick enough to act as a lubricant or insulator and thus



Above, mixing the materials, water tank in background. Lower, laying plant-mixed material.

prevent the particles from naturally cementing themselves together.

The film must also increase the frictional resistance of the particles. Stability against displacement is thus greatly increased by using the hard grades of paving asphalt (50 to 100 penetration at 77°F.). It has been estimated that the thickness of the asphalt film on clay particles in this type of stabilization is about 1/250,000 of an inch.[1]

The formation of such a thin film of hard asphalt can only be accomplished by first separating the particles with a film of water and then by adding the asphalt in the emulsified form in which the particles of asphalt are in colloidal dispersion. It is necessary that the emulsified asphalt be sufficiently stabilized to resist premature breakdown or coagulation until the dispersion of the minute particles of the asphalt through the soil mass has been accomplished by mixing. It is also necessary that the emulsion contain no substances which will soften the final asphalt film or give a water wetting preferential to the coated particles.

After mixing, the asphalt film is formed on the particles by the action of surface tension. As the moisture film becomes thinner the asphalt is drawn by these forces into a thin film on the surface of the particle, replacing the moisture film. Drying after mixing, therefore, finishes the stabilizing operation. Thereafter, the coated soil particles are asphalt coated and water resistant. A quick-drying emulsified asphalt is necessary to facilitate proper drying of the stabilized pavement.

Efficiency of Stabilization

Simple tests have been devised for measuring the efficiency of stabilization and these tests have been compared with actual performance in the field on stabilized projects, thus being confirmed.

These tests consist of making 2-inch by 4-inch cylinders of the stabilized and unstabilized soil. The speci-

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(1) "Soil Stabilization"—By C. L. McKesson. Proceedings Highway Research Board (1935).

mens are dried to a constant weight to complete the stabilization, then placed on a saturated base for 7 days. The absorption increase is then determined. Untreated specimens usually absorb 12 to 20 percent of water in 24 hours, and properly stabilized specimens, 1 to 2 percent in 7 days. It is usually specified that the treated specimens shall not absorb more than 15 per cent as much as the untreated specimens in 7 days.

Stability is determined by placing the cylinders, after the absorption test, wetted and downward, in a heavy 2-inch mold having a one square inch opening in the bottom and applying sufficient load in a compression machine to extrude the bottom half-inch layer. The minimum total load allowable for the treated specimen is usually 10,000, and in properly stabilized specimens the load is usually 20,000 to 40,000 pounds. A very interesting punching shear test for determining stability was described by Mr. Goldbeck.[2]

Design of Stabilized Pavement Mixtures

It has been pointed out that stabilization is accomplished by coating the surface of all of the particles with asphalt. The amount of emulsified asphalt stabilizer required is, therefore, dependent, in part, upon the total surface area. Particle size determinations are, therefore, made by sieving and hydrometer analysis. With particle size determined, the quantity of stabilizer can be determined from the following empirical formula:

$$S = K\ (0.05a + 0.1b + 0.35c)$$

in which

S = Percentage of emulsified asphalt stabilizer.
K = A factor which is constant for any particular type of soil to be treated.
a = Percentage of soil passing a No. 200 sieve (wet method) and coarser than 0.005 mm.
b = Percentage of soil particles between 0.005 and 0.001 mm. in size.
c = Percentage of soil particles smaller than 0.001 mm. in size.

The value of K in this formula varies in different soils due to differences in chemical properties. Usually, $K = 1$. Usually soils on the same project have the same value for K.

Because the quantity of stabilizer is most largely dependent on the surface areas of the particles, and because surface area increases rapidly as particle sizes decrease, great economies are often effected by admixing sand, gravel or rock with the soil. When such granular materials are cheap, they are often blended with the soil until only 20 or 30 percent of the blend passes the No. 200 sieve (wet method), thus reducing the amount of emulsified asphalt stabilizer to or near the minimum allowable, which is 3 percent of the dry weight of the soil or aggregate to be stabilized.

Quarry fines containing clayey or cementitious material, or quarry fines blended with soil are an ideal and often economical material for emulsified asphalt stabilization. This aggregate can usually be stabilized with a minimum amount of stabilizer and has great inherent stability in addition to that imparted to it by stabilization.

Thickness of Stabilized Pavement

As with all other types of pavement, there is no fixed method by which proper thickness can be determined under the varying conditions of subgrade and loading.

Stabilized mixtures in tests show five to twenty times the stability of selected untreated base materials. About one-half the thickness which would be considered adequate for an untreated gravel or slurry base will usually be found sufficient if the same material is stabilized with emulsified asphalt. Due to the increased stability and flexural strength imparted to the pavement in this type of treatment, the thinner base gives a far greater factor of safety. The minimum recommended thickness for stabilized base is 4 inches.

(2) Crushed Stone Journal—May, 1937.

Construction Methods

The soil, aggregate or blends of soil and aggregate, if mixed on the road, are first wet with water. The emulsified asphalt is then diluted, usually with one or two parts of water, and then applied to the material to be stabilized, while mixing proceeds.

Mixing on the roadway is done with blades, spring-tooth harrows, or road mixing plants, after which the treated material is laid out over the roadway and compacted, preferably with sheeps-foot rollers, while it is drying.

Many projects have been constructed with plant mixed quarry fines or pit run gravel, and this type of mixing is very desirable when the cost is not appreciably greater. However, equally good results are obtained with either plant or road mixing.

After the stabilized slab has been constructed and is *thoroughly* dry it is protected from abrasion by any dense bituminous wearing surface. In some cases, and for light traffic, a surface seal coat meets all requirements for a long time. Cold mixed densely graded emulsified asphalt wearing surfaces 1½ to 2 inches in thickness have given splendid results at low cost in many regions where weather conditions were very severe and traffic heavy.

Cooperative Road Building

By F. C. FREAR
County Engineer of Douglas County, Oregon

In Douglas County, which is the largest in western Oregon, reaching from the summit of the Cascades to the Pacific Ocean and containing 5,000 square miles, there are two long rivers—the Umpqua over 200 miles long, and Smith river, 100 miles long, which flows into the Umpqua at Reedsport.

In the Smith river country, which contains about 80 dairy farms, several logging camps, a consolidated union high school, and a Grange, all transportation had been by boat until 1928 when, after making a location survey under difficulties owing to the heavy brush, timber, bluffs, and swamps encountered, a road was started from the upper end of the river, and from one to two miles a year was constructed as funds were available. During this work all machinery had to be moved in on scows.

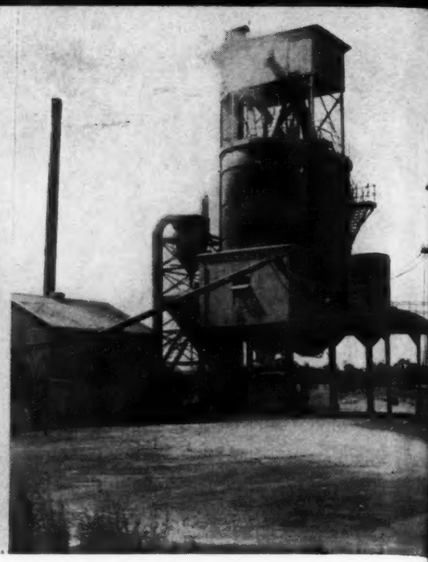
Four years ago this fall the C.C.C.'s under the Suislaw National Forest Service began work on both ends of the road under a cooperative agreement, whereby the County furnished a shovel and operator and a couple of gas boats and agreed to build the necessary bridges, the Forest Service and C.C.C.'s furnishing all other equipment, labor, powder, gas, etc. In order to build the road it was necessary to construct 7 long trestles, 1 movable truss or lift span, and the North Fork of Smith river bridge, which is the longest in the county—an 80-foot covered wooden truss with 760 feet of trestle approach. The road has about one mile of dike, while the balance was of dirt and rock construction, many of the rock cuts being 50 to 60 feet deep.

The County at the present time is just completing the surfacing, which now gives this prosperous community an outlet for Reedsport, its trading center, and the entire county.

Turn to Pages 63-65 for descriptions of helpful booklets and catalogs.

Rolling the Surface

Spreading Tar Mix



Typical Mixing Plant

Tar Plant Mixes

By GEORGE E. MARTIN*

TAR plant mixes under the name of tar macadam or tar-mac have been manufactured and sold in England for many years. Their extensive use in the United States dates back to about 1927.

The tar mixes made in a central mixing plant have certain definite advantages over construction done in other ways. All of the factors entering into the production of a satisfactory combination of tar and aggregate are under control. There need be no variation in the quality and grading of the aggregate. The aggregate is always clean and dry and is at the proper temperature for mixing. The tar is of the proper consistency and reaches the aggregate at the proper mixing temperature. The mixing of the tar and stone is accomplished in a machine especially designed for that operation, and the mixing is continued until all of the aggregate particles are thoroughly coated.

One distinct advantage of tar plant mixes is that only one grade of tar binder is needed for a particular mix. As a result, the consistency of the binder in the road is exceptionally uniform. The surface is smooth, of pleasing appearance, and safe from skidding at any sane speed.

The Plant

The major portion of the tar mixes have been made in stationary plants. However, semi-portable plants have been used in some instances. A typical plant installation would include an aggregate dryer, aggregate storage bins, tar storage and heating facilities, a pug mill mixer, and the usual scales, pumps, conveyors, etc.

The original plants were designed for car shipments and usually contained two one-ton mixers. Due to the increase in the number of plants, very few car shipments are made at present, and this is reflected in a demand for larger mixers in order to decrease the loading time of trucks. Three-ton mixers are not unusual.

Most pavements built of tar plant mix material are constructed in two courses: the bottom course of coarse mix, and the top course of fine mix. There is also a demand for an extra-fine mix for tennis courts, sidewalks, etc.

The coarse mix is fairly open and consists of aggregate about one inch in size coated with about 3.5% of tar binder.

The tendency is to make a close, dense mix for the top or wearing course. The voids in the aggregate are partially filled with fine material, and approximately 7.5% of tar binder is used.

The extra fine mix uses an aggregate with a smaller top size, and the voids are thoroughly filled with sand or dust. About 8.5% of tar binder is used.

Typical aggregate grading specifications for the three grades of mix are given below:

Passing	*Coarse*	*Fine*	*Extra Fine*
1½ inch sieve %	100		
1 inch sieve %	70-100		
½ inch sieve %	10-70	100	
⅜ inch sieve %		90-100	100
No. 4 sieve %	0-10	40-70	95-100
No. 8 sieve %	0-5	25-50	60-100
No. 40 sieve %			10-55
No. 200 sieve %		0-10	0-20

The recommended proportions are as follows:

	Coarse	*Fine*	*Extra Fine*
Tar Binder, % by weight	2.5 to 4.5	6.5 to 9.0	7.5 to 9.5
Mineral Aggregate, % by weight	95.5 to 97.5	91.0 to 93.5	90.5 to 92.5

Accurate control of temperature and grading of aggregate is very necessary. The aggregate should not be above 110°F at the time of mixing, and the tar should be heated to from 150° to 200°F. The required mixing time will usually be about one minute.

Transportation

The mix may be transported to the job in cars or by trucks. The major portion of the material manufactured now is hauled direct from the mixing plant to the job in trucks. The truck body should be coated with a mixture of water and 10% of lubricating oil to prevent the tar mix from sticking to the truck.

Car shipments may be unloaded by hand or by means

*Consulting Engineer, General Tarvia Department, The Barrett Company.

of a clam-shell bucket. A small power shovel which can enter the car has sometimes been used for unloading. Bottom dump cars may be used if an elevated track is available at the point of unloading.

In cold weather it may be necessary to warm material shipped in cars. This may be done by introducing low pressure steam into the mix in the cars through pipes inserted in the mix. Care must be taken so as not to remove the tar from the aggregate by exposing it to continuous steaming action for long periods of time.

Construction

It is assumed that an adequate foundation has been provided to support the load expected on the particular highway. The tar mix forms the wearing course, and while it adds strength to the road, the foundation should not be neglected.

The mix may be spread by hand or by means of a mechanical spreader. Hand spreading is generally used only on small jobs. The machine spreaders and finishers are of two general types: those that travel on the existing road, and those that travel on forms. Either will do a good job and will easily handle four hundred tons and more per day. When a machine traveling on forms is used, care must be taken to keep the forms to exact line and grade at all times, sinces any irregularity in the forms will be reflected in the pavement surface.

The bottom course of coarse mix will usually be from one to three inches thick. The top or fine mix will be placed over the bottom course to a depth of about an inch.

The mix is consolidated by rolling with a flat wheel roller. Both tandem and three-wheel rollers are used. The roller generally weighs from six to ten tons. The mix should not be rolled when wet, since it will not knit together in that condition.

City Indebtedness on Decline in Wisconsin

For the fifth consecutive year the total long-term indebtedness of the state of Wisconsin and its political subdivisions showed a decrease, according to bulletin No. 81, Wisconsin tax commission. The total indebtedness for the year ending December 31, 1936, is shown as $155,188,575 compared with $158,726,054 for the previous year, or a total reduction of $3,537,479.

Outstanding in reducing their indebtedness were the cities, whose indebtedness was reduced for the fifth consecutive year to a total of $68,526,444, or a reduction of $3,522,517 in 1936. This is a total decrease of $24,294,273 from the high point in 1931. County indebtedness was reduced $438,782, leaving $74,278,498 outstanding. School district indebtedness likewise decreased from $5,500,705 for 1935 to $5,115,273 in 1936.

Only the towns and villages showed an increased indebtedness, but in both cases the amount of increase is negligible, for towns being from $1,165,098 in 1935 to $1,880,694 in 1936, and for villages from $4,110,310 in 1935 to $4,203,966 in 1936.

The decrease in city indebtedness is indeed remarkable in view of the fact that tax levies for local purposes have been decreasing for several years, local relief and pension costs have in many instances increased sharply, and cities have made contributions to WPA projects.

Turn to Pages 63-65 for descriptions of helpful booklets and catalogs.

This shows type of salt stabilized road being constructed near Tully, N. Y.

By C. D. LOOKER

Director of Research.

International Salt Company, Inc.

Ithaca, N. Y.

Progress in Road Stabilization With Sodium Chloride

NOT many years ago the old gravel pit was carefully stripped of the clay overburden before the gravel was hauled to the road. Clay was avoided because it was considered a maker of mud in wet weather and of dust on dry days. The "clean" gravel was piled in the middle of the road in summer for traffic to bypass until forced to use that part of the road in winter. Usually, before the following spring, a sort of stabilization had automatically occurred because traffic had smoothed out the gravel and mixed it with the clay in the road over which it had been placed. Partial consolidation had taken place here and there, but this was soon lost because of lack of gradation and uniformity of materials.

By combining, in proper proportions, the clay overburden (or clay from some other source) with these same gravels, road engineers are making mudless and dustless durable stabilized roads, many times at no increase in cost over the older type.

The principles of road stabilization are founded not only on the necessity of well graded aggregate with sufficient binder material but also on the fact that thin films of moisture act as the glue that holds the fine particles firmly bound to each other and to the coarse particles. In road stabilization, just the same as in any other construction involving glue-like binding materials, the thinner the films, the tighter is the job. In furniture manufacture, thin films of glue are secured by pressing the separate pieces together by means of clamps. In stabilized road construction, thin films are obtained by rolling and kneading the well graded material so as to secure the maximum compaction at the optimum moisture content. After compaction is thus obtained it is important that it be maintained in both wet and dry weather in order to keep the road in a firm, stable condition.

Soil treated with sodium chloride (common salt) will compact to greater density at the proper moisture content than soil that has not been so treated; also compacted sodium chloride treated soils do not dry out so rapidly or so completely as untreated soils. Well compacted salt-treated roads retain their compaction because of the ever present thin moisture films. For this reason they resist displacement in dry weather. They do not soften up in wet weather and lose their compaction because the binder portion swells slightly and closes the pores in the already tight surface and shuts off the entrance of enough water to soften the interior.

In the few years that sodium chloride treated roads have been constructed, the mileage has steadily increased until there are more than 1,000 miles in the United States and a considerable mileage in Canada. Included in this mileage are provincial, state, county and township roads, village and city streets, and salt stabilized base courses under bituminous and concrete surfacings. The construction has not been confined to any one locality but extended to include at least 20 different states. The largest concentration so far has been in counties and townships in New York State.

Perhaps the largest mileage of salt roads has been made of pit run material including soil overburden. Mixing has been accomplished by means of power shovels in the pit. Analyses have been necessary in these cases only when using material from an untested pit and the engineer in charge was inexperienced in estimating proper gradation. After the first few jobs, road construction has proceeded without further laboratory control. Nevertheless, due care has been taken to assure proper gradation.

The road engineer can prepare a supply of properly graded material in advance of the construction period; and this prepared material may be run through a crusher to make it conform to proper gradation and to effect a more thorough mixing. By this system, mileage can be built quickly and the method is comparable to the plant mix. The difference is that salt is added to, and mixed in, the top three inches of surface when the proportioned material is added to the road instead of when the storage piles are being made.

In certain localities where roads have been constructed of gravels that are known to make good roads, salt has been added to the lightly scarified and reshaped surface or added to the surface without scarification in the spring of the year when the road was sufficiently moist to dissolve the salt. These roads were thus treated to compact the surface temporarily and conserve material until more thorough stabilization could be carried out later.

Practically all of the salt-treated roads that have

been constructed to date contain only a very small clay content. When salt and proper moisture content are present during the construction period while compaction and setting up are taking place, properly proportioned materials form a dense, tight surface without any large amount of clay. Properly constructed and compacted surfaces remain stable in both dry and wet weather. Many roads now two or more years old have not required more than an annual scraping and treating with additional salt in the spring of the year.

The low clay content in salt-stabilized roads is undoubtedly a factor in their ability to form a strong bond with bituminous or concrete surfacings. Also the almost complete absence of frost boil trouble in the stabilized mat has been of considerable value both when used as a wearing course and as a sub-base, reducing maintenance costs.

Using Quarry Screenings

Localities in which both proper binding material and necessary aggregate occur near each other are somewhat limited. It has not proven economical to transport material over great distances if stabilized roads are to be kept in the low-cost field. Repeated experiences have shown that this condition can be met in part in certain regions by the use of sodium chloride treated quarry screenings, especially those of limestone. In a number of quarries great piles of fairly well proportioned screenings have accumulated over a period of years as a by-product from other operations. These are being put to good use in making what might be called salt-bound-stabilized limestone roads or salt-bound stabilized macadam. Salt makes limestone more soluble than it is in plain water and adds to its natural binding qualities.

These screenings are being used without the addition of any clay as binding material. The fine limestone dust and salt serve to hold the coarse particles in a firmly bound stabilized mat. In some cases additional clay has been used, and in still others crushed limestone has been used to advantage as the coarse aggregate in clay stabilized roads. Outstanding roads containing salt treated limestone or limestone screenings have been constructed in Maryland, Indiana, Illinois, Michigan, New York, Pennsylvania and Ohio.

Engineer's Fee for Planning Unconstructed Sewer System

In an agreement between an engineer and a city for services rendered in planning a sewer system for the city, the construction of which was not carried out, the amount of payment under the contract was to be 50 per cent. of 6 per cent. of the cost of the system, to be paid at the time of the letting of the construction contract, and another 50 per cent. from month to month during the progress of the work. The estimated cost of the work under the contract was $44,463. The jury found the cost would have been $44,000. The plaintiff performed all the services required up to the time of letting the construction contract. Had he also been required to perform consultation and supervisory services during a construction period he would have been entitled to $2,640. The jury in answer to a special question awarded $1,320 as reasonable compensation for the services rendered. Judgment for that amount was affirmed. The city's ability to construct the sewer was not in issue. City of Kirbyville v. Thackville, Texas Court of Civil Appeals, 108 S. W. (2d.) 226.

How to Lay Cement Bound Macadam

By FRANK T. SHEETS

President, Portland Cement Association

CEMENT bound macadam is not a new type of pavement; prior to 1925 it was known as Hassam pavement. With the expiration of patent rights, construction practically ceased. A few projects undertaken in 1932 indicated a lack of detailed information as to proper methods of construction. Accordingly, the Portland Cement Association undertook, early in 1933, the construction of an experimental test road near Elmhurst, Ill. The more important conclusions, since substantiated by further experience, were:

(1) Any type of coarse aggregate suitable for concrete can be used for cement bound macadam. Broken stone, gravel, slag and broken bricks have all been successfully used.

(2) Coarse aggregate having not more than 5% passing a ¾" sieve or more than 5% retained on a 3" sieve can be used. The spread between the maximum and minimum sizes should not exceed 1½". Small sizes are more difficult to penetrate with grout. Large sizes require more grout and are more difficult to finish. The 1"-2" and 1½"-2½" sizes are recommended as most satisfactory.

(3) The type of coarse aggregate has little effect on strength, but large sized coarse aggregate gives somewhat higher strengths than small sized aggregates.

(4) The size and kind of coarse aggregate determine the preferred grout fluidity.

(5) Grout fluidity is influenced by size, shape and gradation of sand and by the proportions of sand, cement and water. Too much water may cause segregation; coarse sand segregates more readily than fine sands; lean mixes more readily than rich mixes.

(6) Grout proportions of 1:2 by weight are satisfactory and most commonly used, although proportions from 1-1 to 1-2½ have been used successfully.

(7) Medium sands (95% passing the number 8 sieve) give best results for strength.

(8) Compaction of coarse aggregate, except gravel, prior to grouting reduces grout requirement and loss of aggregate into the subgrade. Final compaction after grouting has some influence on strength but does not aid penetration. A 5-ton roller used for this purpose results in slightly higher strengths than one of less weight or compaction by hand.

(9) Final compaction should be applied at a suitable interval of time after grouting to be most effective in increasing strengths, and obtaining a smooth riding surface.

(10) Compressive and flexural strengths compare favorably to the strengths of mixed concrete having water-cement ratios similar to that of the cement bound macadam at the time of final compaction.

(11) Grout quantities about 17% in excess of the amount required to fill the voids in the coarse aggregate are necessary. This excess is required because of the loss of free water after grouting.

A West Virginia highway built by contract, one lane at a time.

A device for determining and comparing grout-making properties of sands and for controlling the fluidity of the grout during actual construction is the "flow cone." This consists of a funnel having a capacity of 221 cubic inches, into the bottom of which is fitted a discharge tube ½" in diameter and 1½" long. The time in seconds required for the cone to empty when filled with grout was found to be a satisfactory measure of the fluidity of the grout.

During grouting operations, the coarse aggregate tends to become displaced. Neil Howes, Superintendent of Public Works of Glens Falls, N. Y., solved this by placing a ¾-inch mesh wire netting over the coarse aggregate during grouting operations. This permits brooming excess grout forward with a minimum disturbance of the coarse aggregate. As grouting progresses, the wire netting is moved forward.

Details of Construction

The details and methods of construction of cement bound macadam vary slightly from job to job. Usually the type of equipment available determines the method used. In general, the equipment for relief labor projects has consisted of a concrete mixer of 1 or 2-bag capacity equipped with a distributing spout; a few wheelbarrows; a wooden or steel longitudinal tamp; wire netting; 1000 to 2000 feet of wooden or, preferably, steel forms; burlap for early curing; 200 to 400 feet of ¾-inch rubber hose; and small tools such as shovels, picks and finishing tools. In some instances a wheelbarrow scale is used to proportion the sand for the grout; in others a cu. ft. box is employed for this purpose. In case the mixer is not equipped with a water tank, water is measured in a graduated pail from a supply barrel alongside the mixer.

Where there are existing pavements, the top surface is removed and the old base prepared for use as a subgrade. Forms are set to permit a "lane-at-a-time" construction. These lanes vary in width from 8 to 14 feet and are usually laid out to correspond to the proposed traffic lane markings of the finished surface. It has been found by experience that lane-at-a-time construction facilitates distribution of the grout and finishing operations.

The coarse aggregate is then spread between the forms, to a depth which after compaction, will provide

a pavement of the specified thickness. The additional depth of loose coarse aggregate necessary depends upon its nature and the amount and kind of compaction used. This additional depth can be readily ascertained by trial.

The next step is to grade the top surface of the coarse aggregate to the desired crown and profile. This is important, as the accuracy of this work has an influence on the final surface smoothness. A transverse template set slightly higher than the desired elevation of the coarse aggregate is placed on the forms as a guide in leveling the coarse aggregate. The surface of the coarse aggregate should be carefully graded to an elevation parallel to and slightly below this template.

After the coarse aggregate has been placed and graded as described, it is compacted by a roller, or by hand with a 10-ft. longitudinal tamp, having a tamping face width of 3″ to 5″, weighing at least 150 lbs., and equipped with plow handles on each end to be operated by two men.

After rolling or tamping, the surface of the coarse aggregate is checked with the transverse templates and the irregularities corrected.

Mixing Equipment

A 7-S or 10-S mixer is usually employed for mixing the grout, although paving mixers may be used. Regardless of the type, a spout should be provided which will reach from the mixer to within a few feet of the furthest pavement edge. A distributing box with the bottom perforated is usually attached to the end of the spout. The capacity of a mixer is limited to the quantity of grout that can be mixed without spilling, and is ordinarily less than the rated capacity of the mixer.

The mixer is placed outside the forms whenever possible. The surface of the coarse aggregate is covered with strips of wire netting laid transversely across the pavement before actual grouting starts. If the spout on the mixer is provided with a swivel, the grout can be distributed by slowly moving the spout. If the spout is stationary, the grout is distributed by brooming.

The penetration of the grout through the coarse aggregate can be checked during grouting by digging test holes the full depth of the aggregate at some distance ahead of grouting. If unsegregated grout is observed to enter these holes at the bottom when the grout on the surface of the aggregate is one foot or more away, full penetration is assured.

Final compaction of the grouted coarse aggregate

Left, pavement repairs are made with a small crew and simple equipment. Right, curbs can be built integrally with cement-bound macadam.

At Morrisville, Vt., a small mixer with spout and distributing box was used.

should not be undertaken until it is apparent that most of the free water has escaped. Rolling is best; but a tamp gives good results if the entire surface is thoroughly tamped from two to four times. After compaction, the surface is smoothed by the use of long handled floats, and tested for surface smoothness by a ten-foot straight-edge. If the surface of the coarse aggregate has been brought to the proper contour before grouting and protected against displacement during grouting, few if any irregularities in the surface will be found.

The final finish is obtained by dragging the surface with a strip of wet burlap or by belting. The surface may be broomed if desired.

The pavement is protected against rapid drying by covering with wet burlap. This may be left on the surface and kept wet for 48 to 72 hrs.; or the following day, any one of the various methods used in curing concrete pavements may be substituted for the wet burlap.

While hand methods have been most common on relief projects, the work can be expedited by the more extensive use of equipment. On many projects some or all of the following equipment has been used: Subgrading machines; stone spreader boxes; large paving mixers; batch trucks; transit truck mixers; five-ton tandem or three-wheeled rollers.

Use in Pavement Repairs

Cement bound macadam has been used efficiently for repairing concrete pavement. Either new coarse aggregate is used or the removed concrete is broken up in small fragments and used as coarse aggregate. Hand methods are usually employed. Some of the advantages of using cement bound macadam for such repairs are:

(a) Eliminates the concentration of construction equipment units on the road and at locations to be repaired.

(b) Operations for the removal of the old concrete and the replacement can be carried on separately and more or less independent of one another.

(c) Filling the holes with crushed stone immediately after removal of the old broken concrete greatly reduces the traffic hazard during replacement.

(d) The crushed stone need be handled only once—direct from storage pile to hole.

(e) Grouting operations are simple and the idea of the whole operation is readily grasped by men doing the work.

(f) Shrinkage of the replaced area is greatly reduced by late tamping.

(g) Strengths are satisfactory and apparently danger from damage under loads is greatly reduced by the mechanical interlock of the coarse aggregate.

(h) In appearance the patches do not differ greatly from the old concrete pavement.

Building Bituminous Macadam

R. H. BALDOCK

Engineer, Oregon State Highway Commission

STANDARD 3-inch bituminous macadam wearing surface used in the state of Oregon is built in the following manner: Upon a compacted and drained subgrade there is placed a ballast course of gravel or stone talus ranging in thickness from 12 to 24 inches, depending upon the character of the traffic to be sustained and the strength of the subgrade. The ballast is placed from ditch to shoulder line. Wherever possible a sandy gravel is used, and where there is insufficient sand, a sand filler is added. This gives a very permeable base that effectively drains off the water. The subgrade is slightly crowned which prevents the formation of water pockets. Upon this ballast or foundation course, there is placed a base of chock stone macadam 4½ inches in compacted thickness, the course being constructed 4 feet wider than the bituminous macadam wearing course which it is to carry. The size of the stone ranges from 4½ to 2½ inches. It is spread with bulldozers and smoothed with motor graders, with such hand spotting as may be required. After it has been rolled, the coarse stone is keyed with ¾-inch minus materials. The surface is then protected by a prime coat of from 1/3 to ¼ gal. per sq. yd. of rapid-curing cutback asphalt which is immediately covered with a small amount of screenings and rolled.

Constructing the Wearing Surface

The bituminous macadam wearing surface is then constructed upon the prepared foundation and base. Usually the wearing course is 22 feet in width; 2½ to 1¼-inch stone is spread with mechanical spreaders at a rate of .06 cu. yd. per sq. yd. After this has been thoroughly rolled and hand spotted to a true and even contour and grade, bituminous cement is applied at the rate of one gallon per sq. yd. and this is followed immediately with a spread of 1¼-¾-inch material in the amount of .02 cu. yd. per sq. yd. The finer part of the material serves to chink up the interstices of the larger stone, whereas the coarser part serves as a leveling course to take out the small irregularities of the first course. The surface is planed with long wheel base motor graders, after which it is rolled and a second application of bituminous cement applied at the rate of ⅜ gal. per sq. yd. The asphaltic cement is covered with ¾ to ½-inch aggregate at the rate of .009 cu. yd. per sq. yd. and ½ to ¼-inch aggregate at the rate of .003 cu. yd. per sq. yd. The first seal coat is then applied. The seal calls for a ⅜ gal. application of bituminous cement followed by a spread of .006 cu. yd. per sq. yd. of ½-¼-inch aggregate and .003 cu. yd. of ¼-inch minus aggregate. The material is broomed and rolled until thoroughly compacted. Traffic is then allowed to use the road for a period of four or five days, after which the second seal, consisting of ¼ gal. of bituminous cement followed by a spread of .006 cu. yd. per sq. yd. of ½-¼-inch aggregate and .004 cu. yd. of ¼-inch minus material, is applied.

The asphaltic cement is a 120-150 penetration asphalt heated to a temperature of 425°, the same grade

being used in all applications with the exception of the second seal coat. A water-soap solution is sprayed into the road with the asphaltic cement through the same openings in the spray nozzles, the quantity of solution used being about ten per cent, by volume, of the quantity of asphaltic cement. The temporary emulsion thus formed coats the stone thoroughly. The asphaltic cement in the second seal may be either cutback asphalt or emulsified asphalt. Each square yard of the bituminous macadam requires two gallons of bituminous cement, including the cutback or emulsion, and .111 cubic yard of aggregate. Each course of the pavement is thoroughly rolled with 10-ton, 3-wheeled rollers, until the stone is mechanically locked.

The surface texture of this type of pavement is somewhat coarser than a sandpaper finish, the ½-inch stone and the ¼-inch stone being evident. The voids in the base stone act as a reservoir to absorb excess asphalt in hot weather with the result that this type of pavement seldom bleeds and remains remarkably uniform in texture throughout the years. Oregon's experience with this type of surfacing extends over a period of about ten years.

Skid-resisting and Non-glare

One of the main objectives in the building of pavements is the creation of a surface that has skid-resistant properties and one that minimizes the reflection of "glare" of the headlights of oncoming vehicles. The pavement above described satisfies both of these requirements.

Experiments carried on by the Oregon State Highway Department indicate quite clearly that smooth textured pavements reflect more light than pavements having surfaces of rough texture. The reflective glare from wet surfaces is in the main a function of the texture of the surface and the least glare is given by those surfaces which are so deeply indented or grooved that water is not held by surface tension but drains off with sufficient rapidity to prevent the flooding of the entire surface and the formation of a water film which acts as a mirror in reflecting the lights of approaching vehicles. The presence of a film of water on pavements thus has the double effect of decreasing the skid resistance between the tire and the pavement and of forming a mirror which causes objectionable glare in night driving. The texture of the Oregon type of bituminous macadam is such that it meets the requirements of both resistance to skidding and elimination of glare.

The bituminous macadams of Oregon are built almost entirely by machines with the minimum of hand labor. They compare favorably in smoothness of riding surface and nonskid properties with similar pavements laid elsewhere. The cost range is wide due to varying availability of the materials, varying character of subgrade and varying amounts and character of the traffic. Under most favorable conditions, the cost, including foundation and base courses but not including grading, totals about $10,000 per mile. Under extremely unfavorable conditions, the cost will run as high as $20,000 per mile. Such roads carry a traffic ranging from 500 to 2,000 motor vehicles per day. The average cost of maintenance of this type surfacing over the past three years has been $150 per mile annually.

Bituminous macadam pavements constructed on well drained subgrades and with adequate foundations, have demonstrated their ability to successfully withstand heavy traffic and to render a traffic service quite comparable with that of the higher types of pavement. Like other flexible types of surfacing, however, the

wearing surface itself has no very considerable spanning strength. Strong and durable foundations are, therefore, essential to its success.

The above is composed of extracts from a paper on this subject by Mr. Baldock. The paper was presented at the meeting of the Asphalt Institute, Memphis, Tenn., in December, 1937.

Coloring Concrete Surfaces

In describing the methods of constructing concrete tennis courts, the Portland Cement Ass'n gives the following information on coloring the concrete.

Colored surfaces may be obtained by mixing mineral colors with the concrete that is to be placed in the top 2 in. of the slab, using the same mix as for the base course. These colors for the most part consist of stable oxides such as iron (buff to red), chromium (green), and manganese (gray). A saving in the cost may be made by coloring the playing surfaces only, leaving the back courts uncolored. In general, not more than 5 to 6 lbs. of color per sack of cement will be required. It must be remembered that the natural color of a concrete court may become darker the following year.

In California it has been the practice to use stain, the colors for which can be obtained as follows:

Green—Copper chloride 15-25% solution.

Brown—Ferric chloride 15-30% solution.

Dark brown—add 15% of a 50% solution of strontium nitrate to ferric chloride.

Before proceeding with staining, it is recommended that the colors be tried out on a small panel. Stains may be painted or sprayed on; however, concrete should be well set up and dry before application.

Further reference to staining concrete will be found in the *Journal of the American Concrete Institute* for Nov. 1932.

Traffic Signal Accidents

The Nassau County Court holds (Murphy v. Village of Farmingdale, 298 N. Y. S. 578) that, under the New York prior decisions, a village, in the maintenance of traffic signals on, above, or beside a highway, is exercising a police or governmental function as an agency of the state. In the present case the village was held not liable in damages for injuries resulting from the collision of an automobile, in which plaintiffs were riding, with a traffic control signal located in the intersection of two public highways within the village.

Municipal Debt for Engineering Work Done

A Mississippi statute authorizes municipalities to acquire, own, and operate airports and "to do all things and perform all acts necessary, proper or desirable to effectuate the full intent and purpose of this act." A municipality contracted for the necessary engineering work upon an airport to be located near the town, agreeing to pay therefor $300. The work was done and the bill allowed. An order was entered on the town's minutes for payment "when funds are available." Fifty dollars was afterwards paid. Two years later the engineer sued for the balance. The Mississippi Supreme Court held, Town of Magee v. Mallett, 174 So. 246, that, although the original contract was oral, whereas it should have been entered upon the town's minutes, it could be, and had been, ratified under the rule that a municipality, in the absence of express statute to the contrary, may subsequently ratify a previously unen-

forceable contract which it had the power to make, when the work has been done and the benefits thereof received. The court assumed the town had funds in hand at the time the contract was made and that the order merely meant that no funds were available at the time of the order of allowance, so that under the statute no warrant payable at once could be ordered; but the board of aldermen had the duty to make the funds available within a reasonable time. Judgment for the plaintiff was therefore affirmed.

New Ideas in Brick Paving

Brick Pavements Rolled on Boards

The usual specification requirement provides that after the paving brick have been laid and have passed inspection the pavement shall be rolled in a prescribed manner with a self-propelling roller, weighing not less than three nor more than five tons. Rolling on boards is a recent innovation that originated in Richmond, Virginia, and is meeting with increasing favor elsewhere. It was used on the recently constructed brick pavement in the Lincoln Tunnel under the Hudson River in New York City. It has the advantage of permitting the use of heavier rollers such as most contractors have on hand for sheet asphalt construction. The brick are uniformly embedded vertically with the minimum displacement laterally. The joint lines remain straight, which is desirable from the standpoint of appearance.

The Richmond specifications required use of a power-driven tandem roller weighing between five and ten tons, on boards not less than 10" wide and 12 ft. long, dressed to a uniform thickness of 13/16 inch, laid longitudinally and in close contact. Rolling to start at one curb, the roller progressing not more than 10" tranversely at each longitudinal roll, which shall be at at least 24 ft.

Plasticized Sulphur as Jointing Material

In a test pavement on Ohio Route 31 in Hocking county, 13 different materials were used as fillers. The results with two of these, two types of plasticized sulphur, after a year's service were described by W. W. Duecker and H. Z. Schofield in a paper before the American Ceramic Society. Plasticized sulphur A consisted of sulphur plasticized with 10% of an olefine polysulphide and contained 30% by weight of a graded aggregate. B was sulphur plasticized by the addition of 60% by weight of air-blown asphalt. Both are melted and poured into the joints, A penetrating to the bottom of the joint better than any other material, probably because of its low viscosity, high specific heat, low heat conductivity and high specific gravity. Heating it above 180° C decomposes it and must be avoided. B decomposes above 214° C, filled the joints probably better than asphalt. An objection to A is its obnoxious odor.

Both form tenacious bond with the brick and fill the joints flush with the pavement surface, and do not exude in hot weather. After more than a year's use, A has the consistency of hard leather. It is plastic, but is semisolid and protects the edges of the brick. But it probably will not be used in its present form because of its odor and the difficulty of controlling the heating. B can be melted and handled like aphalt and resembles it in physical appearance. It is sufficiently flexible to be deformed by any movements in the pavements itself, either those due to traffic vibrations or those caused by temperature changes.

No data as to the cost of these fillers are given by the authors.

Sanitary Engineering

Additional Water for Air Conditioning in Chicago

Laying additional main for air conditioning in Chicago

For the past year or two, as we have several times had occasion to state, water works men have given increasing attention to the water consumption demands, present and anticipated, of the rapidly growing service of air conditioning. Deservedly or not, Chicago is frequently cited as a leader in experiencing what is threatening all of us. It is estimated that on October 1st there was, in a square mile of the loop district, 16,328 tons of air conditioning capacity, approximately 40% of which was concentrated in six blocks on State street; and that this district now requires 47,000,000 gallons of water a day for air conditioning equipment. One of the largest stores uses 3,000,000 gallons a day.

To meet this demand, Chicago is laying new mains. It now has in use 3,652 miles of mains, of which 23 miles are 48″, 101 miles are 36″, 117 miles 24″ and 1,575 miles 8″ pipe, with addition lengths of sizes up to 54″ and down to 6″. All of this is cast iron. At present a line of 16″ is being laid in State street to supplement the old mains laid in 1854 and still "as good as new."

The new line will not only give increased distributing capacity but will also give the advantages of a two-main system. This is especially advantageous in this case because the old main lies directly under the car tracks in the center of the street which makes it difficult to reach it for making connections.

The matter of water consumption has been given serious consideration by the Air Conditioning Manufacturers Association, which announces that they are prepared to furnish "apparatus that cuts water use 90 to 95 percent. There is no reason why the widespread use of air conditioning should tax the facilities of any community, if there is teamwork between manufacturers and city authorities, with equipment being selected to suit particular requirements in the respective communities."

Many cities and towns find or anticipate inadequacy to meet air conditioning demands because they are barely or not quite able to meet recent growth in consumption demands for other normal purposes. In some cases it will be found more economical for the citizens to increase the water supply sufficiently to permit the use of air conditioning equipment which uses large quantities of water; but where the more expensive equipment using less water is more economical, the manufacturers can furnish it.

City and College Cooperate in Study of Sewage Treatment

The City of Cleveland will cooperate with the Civil Engineering Department at Case School of Applied Science in studying the various methods of sewage treatment. More than fifteen hundred dollars worth of sanitary and biological engineering equipment has been loaned by the City Department of Public Utilities and is being set up at the College for use in teaching as well as research work.

The equipment includes sinks, autoclaves, tables, drying ovens, muffle furnaces, refrigeration equipment, cabinets for determining bio-chemical oxygen demand, plate counters, chemicals and tools. According to Professor George E. Barnes, the new equipment will greatly improve the work in Sanitary Engineering at Case and will undoubtedly provide much valuable information to the city on sewage treatment problems which concern the health and safety of the general public.

Utilities Director F. O. Wallene, Chief Engineer L. A. Quayle, Easterly Sewage Plant Director J. J. Wirts and J. W. Elms, Director of Water and Sewage Treatment, are the men responsible for the city's action, and all will assist in some measure in the research projects which have been planned. The equipment, which was formerly at the Easterly Sewage Plant, is in excellent condition and has been made available to Case because of the new, more compact apparatus which has been purchased by the city to conserve floor space.

Digester Gas Dangers

Like any other inflammable material, gas from digestion tanks should be handled with caution. Two recent happenings in Illinois illustrate this.

At Macomb the production of digester gas suddenly fell off a few weeks ago. Investigating in the basement of the service building, operator Dan Alford lit a match and found where some of the missing gas was. Fortunately only a little of it was there and no damage was done. He found that the gas line from the tank had settled outside the basement wall and opened slightly at a joint, from which gas had escaped and some of it followed along the pipe into the basement.

An entirely different experience with gas utilization equipment was that of Bill Hayes, operator of the Monmouth plant. He had taken down a condensate trap for servicing, and while scraping out an accumulation of harmless looking, black material, he felt a spark on his arm and promptly "called down" his helper for smoking while working on the gas system. Protesting his innocence, the helper pointed to the black "dirt" that had come from the gas lines and trap and Bill saw that the whole pile was now a glowing mass of fire!

The black substance was apparently iron sulfide which may be produced when hydrogen sulfide attacks iron or steel. This compound oxidizes in the presence of air and sufficient heat may be generated to cause ignition. Watch out for it in your plant.

Briefs

Studies of the Flow of Water in Bends

Studies of flow of water in bends of pipe were made by the late David L. Yarnell, of the Drainage Div., U. S. Bureau of Agricultural Engineering, in cooperation with the University of Iowa. Six-inch pipe was used, and celluloid pipe was used for the bends and adjacent sections. While the friction was undoubtedly less in this than in iron or other common kinds of pipe, and probably the turbulence also, it is believed that the ability to see the water flowing through the bends permitted learning more about the actual flow than was known before.

Among the conclusions drawn by Mr. Yarnell from these studies are the following:

The velocities of the filaments of flow along the inner side of the bend are increased and those along the outer side are decreased in their approach to the bend.

The loss of head increases with increase in length of the bend for pipe of equal size, equal radius of curvature, and like material and condition, and is greatest for a miter bend made by joining directly two straight pieces of pipe cut obliquely, with no intervening curved section.

For a given pipe bend and given quantity of flow, the head lost in the bend is influenced greatly by the velocity distribution in the part of the pipe at the approach to the bend.

From the difference between the pressures on the inner and outer sides of a bend at the point of maximum difference, and having the size of pipe and the radius of curvature of the bend, it is possible to compute the mean velocity and therefore the quantity of flow. In other words, when a pipe bend has been calibrated it may be used as a flow meter with which the discharge can be determined merely by measuring the difference in pressure of the inner and outer sides.

The losses in the pipe bends used in these experiments appear to vary as the square of the velocity, and not as the 2.25 power as suggested by some writers.

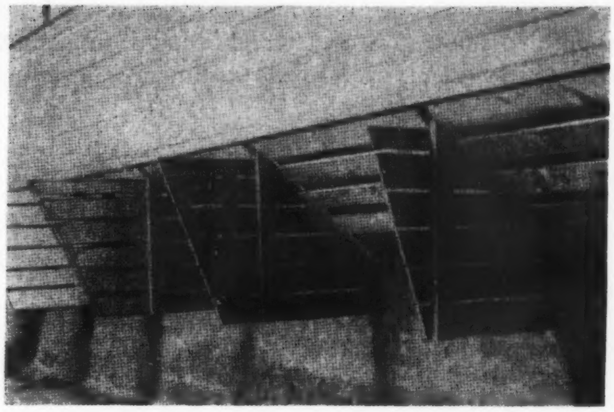
The bulletin makes several practical applications of the results. Because it was found that a single pressure reading on a bend or close to a bend may not give the correct average pressure for the cross-section at that point, it is recommended that in such work as making efficiency tests on pumps, the pressure (piezometer) determinations be made at several points on any section.

Since the experiments showed much greater loss of head in bends of reverse curvature than those of continuous curvature, it is emphasized as advantagous in all pipe installations to avoid, as far as practicable, the reversal of direction of curvature by bends placed near together.

From the results on loss of head resulting from the lack of uniformity in velocity in the approach to bends, it is clear that in planning pipe lay-outs if two bends on the same line curve in the same direction, the second will cause less loss of head than the first if they can be placed close together.

(The suggestion that a bend be used as a flow meter calls to mind the fact often stated that any obstruction in a pipe which causes change of veloctiy can be used as a meter after it has been calibrated, but there are many advantages in using one that can be exactly duplicated and standardized, such as a venturi contraction or an orifice. A bend of exact size and radius and perfectly smooth surface could be standardized, and connecting the piezometer tubes to opposite sides of the same bend offers some advantages; but on the other hand, the velocity difference in the bend depends to a considerable extent upon the distribution of velocities in the pipe ahead of the bend, which it may prove difficult to control.)

These experiments are described in Technical Bulletin 577, copies of which may be obtained from the Superintendent of Documents, Washington, D. C., at 15 cents a copy.



Sperry's baffles in Aurora primary tanks and as installed at Wheaton, Ill.

Wheaton Settling Tank Baffles

The Illinois Department of Public Health has recently reported that, as a preliminary to making plant improvements at Wheaton, Walter Sperry of Aurora and Mr. Barnes, superintendent of the Wheaton plant, collaborated in a study of the efficiencies of the primary settling tank, and increased the removal of suspended solids 25% to 30% by installing the inlet baffles designed and installed by Mr. Sperry in the Aurora tanks. These are shown in the illustration at the top of this column.

No Damages Allowed Where Discharge of Sewage Is Discontinued

A city constructed a sewer system, with a disposal plant which, because of inadequacy, discharged solid matter upon land, the owner of which sued the city for damages. After the institution of the action the city improved its disposal plant by installation of filter beds, etc., after which the discharge consisted of water only, admittedly causing no damage. The land was mainly unimproved, without buildings, and there was no damage to the rental or usable value of the premises. The South Dakota Supreme Court held, Gotwals v. City of Wessington Springs, 244 N. W. 649, that no permanent damage had been done to the freehold and therefore reversed judgment for the plaintiff.

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

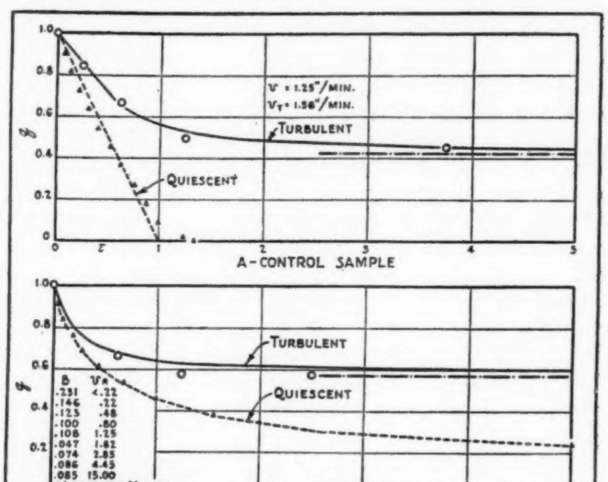
Residual chlorine determination by the potassium dichromate-copper sulphate standards of "Standard Methods" is satisfactory only in 300mm. depth of liquid; for other depths the orthotolidine-chlorine color is not simulated. R. D. Scott in 1935 suggested standards prepared from buffered chromate-dichromate solutions, which match the color for any depth of liquid; but finds that on standing a month a precipitate is deposited. He now suggests gold chloride in hydrochloric acid solution, which apparently "matches exactly in hue and intensity that produced by orthotolidine and chlorine," does not deposit any sediment and has not faded after three months, and can be used with any depth of liquid. One ampoule of gold chloride, costing about $1.24, is sufficient for preparing a series of standards up to and including 0.5 ppm. of chlorine.[A11]

Sedimentation in a turbulent viscous fluid has been studied by Prof. Slade and "a consistent dynamical theory of sedimentation is developed." It is assumed as possible to determine the distribution of "hydraulic values" of the settling material; the "hydraulic value" of a particle being defined as the speed with which it settles in a still basin, and represented by v, and the distribution being the ratios of the amounts of particles which settle at each of a number of rates. At any given moment the actual rate of descent of a certain particle is its hydraulic value less any upward impulse due to turbulence in the liquid. The "turbulent velocity" is the root-mean-square of all the vertical velocities of the liquid in the basin; it fluctuates somewhat, but the author uses the average for the period of retention in the basin. The average of all the vertical velocities in the basin is zero, since the net vertical flow of the basin is zero. The author has developed a formula to "be regarded as a statement of the probability that a certain amount of sediment be found in suspension after the lapse of time t," and he is convinced "that the design of settling tanks may be placed on as precise a foundation as that, for instance, on which rests the design of trusses." The formula applies only if the turbulent energy is uniformly distributed throughout the basin, and there is no marked stratification of the fluid, conditions which, Prof. L. V. Carpenter said in his discussion, the designer has been attempting to get for years but with little success. Prof. Slade cited as confirmation of his theory experiments with powdered quartz, first with a sample having v=1.25" a minute and retained in a turbulent tank for 1, 2½, 5 and 15 min. (Fig. 8A) and then a sample with hydraulic values distributed as shown in Fig. 8B. In each illustration the curve was calculated from the formula and the circles obtained by the experiment.[A12]

A turbidicator is installed as part of Denver's Moffat filter plant, consisting of two parts, a photo-cell unit mounted on the wall near where the inlet coagulated water enters the filter building, and a signal or remote control unit mounted with the other plant gauges, indicators, etc. Coagulated water from the main influent ahead of the filter is fed continuously into the turbidicator. "Any change occurring in the turbidity of the water through which the light source is directed will be instantly observed by the photo-cell and relayed to the signal panel. If there is an increase in turbidity, the needle will swing to the left of the zero mark on the meter and strike an adjustable contact, thereby closing the gong and red light circuit; if there is a decrease in turbidity the needle will swing to the right, thereby closing the gong and green light circuit." Notified by the gong, the operator can act accordingly. The equipment has not yet gone into regular service. It is believed practicable to use the turbidicator with filter effluent so that it will automatically backwash the filters if any turpidity appears.[F4]

Two concrete tanks 30 ft. diameter and 25 ft. high were built at Sherburne, N. Y., instead of one 44 ft. tank 20 ft. deep, giving 16% greater capacity but requiring less concrete and reinforcement. They were built with a Polk form (used for silo construction) for 8" wall, in which a central gin pole supports two steel skirts 4 ft. high, which are raised by jacks after each run. Copper diaphragms were used between the floor and the walls and in the horizontal construction joints. The inside faces of the joints were rubbed down and a 3" belt of Inertol plastic applied. With 15 ft. depth of water in the tanks there was no leakage or indication of moisture on the outside surface. The density of concrete and resulting imperviousness are attributed to the forms used, care in mixing the concrete, shallow depth of spading required, methods of placing, diaphragm joints, and lack of any ties between the inside and outside forms.[F1]

Air conditioning equipment, connected to public water supplies, should include none of the following hazards:



American Water Works Ass'n.

Results of experiments in sedimentation of powdered quartz.

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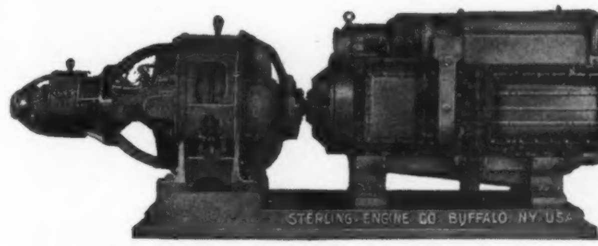

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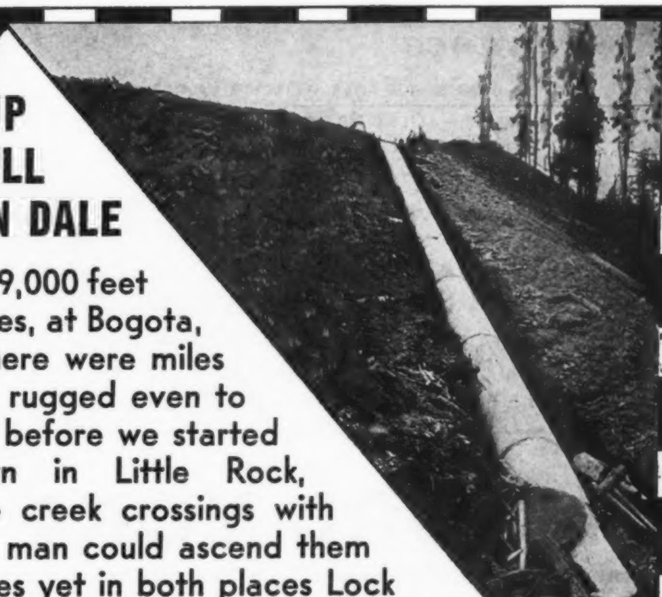

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Established 1905

LOCK JOINT Rein-forced CONCRETE PRESSURE PIPE

Turn to Pages 63-65 for descriptions of helpful booklets and catalogs.

Direct or continuous water connections from pure water mains to condensers or gas compressors for cooling purposes; direct connection of waste from a condenser or compressor to any part of the drainage system; direct cross-connection, or provision therefor, between the city water and an auxiliary supply; re-use of condensing and cooling water in the domestic supply; making of water and waste piping connections to such equipment by any but skilled and licensed men. Avoidance of direct connection is usually effected by interposing an air gap. Water supply inlets to collecting pans in air washers, de-humidifiers and to cooling ponds or towers must be above the highest possible water level.[A1]

Softening plants in the United States (municipal supplies) numbered, October 1, 1937, a total of 348, of which 85 used the Zeolite process. There were no softening plants in New England, or in Colorado, Delaware, Idaho, Maryland, Montana, Nebraska, Nevada, Oregon, Tennessee, Utah or Washington. Ohio contained by far the largest number—67 using lime and 21 Zeolite. Illinois had 27 lime and 15 Zeolite; Pennsylvania 28 lime and 9 Zeolite; Florida 26 lime and 3 Zeolite; Kansas 24 lime, no Zeolite; Iowa 17 lime, 4 Zeolite; Missouri, 16 lime, 4 Zeolite; Michigan 10 lime, 2 Zeolite. No other state had as many as ten.[A2]

The most pressing problem in water softening today is—how can the colloidal precipitates produced in recarbonated water be removed quickly ahead of the filters. Also—what should be the alkalinity and pH value of a lime-softened water to make it behave properly in distribution system and household plumbing.[A3]

Chlorine demand determinations by the standard methods are "quite unsuitable for finding the dosage of chlorine in ammoniated water. In water purifying plants using ammoniation the dosage of chlorine is chosen empirically and then verified by bacteriological count," which is undesirably slow for operation under variable conditions. The now-existing iodometric method does not take into consideration the influence of the initial dosage of chlorine on the chlorine demand and the influence of ammonia on the same; or of acidification during back titration of the residual chlorine. Prof. M. L. Koshkin describes a proposed method for determining the dose of chlorine for ammoniated water which "takes into consideration the value of initial chlorine, the value of half-bound chlorine, and the diminished chlorine demand of water upon influence of ammonia. When so determined, the chlorine dose always produces a fair bactericidal effect. When the dose of chlorine is determined according to our method the residual persists for a sufficiently long period." But "Further verification of this method in plant practice is necessary to demonstrate its practical importance."[A9]

Softening water of 65-70 grains hardness to 6 grains in a Zeolite plant using sea water for regeneration was begun on April 15, 1937, at Sarasota, Fla.—believed to be the first municipal plant of its type. The operating costs per unit of hardness removed, ($14.00 per million gallons, or about 23 cents per unit) are only a fraction of those of any other type of municipal softening plant. It was estimated that the operating cost of a lime-soda plant would be $193 a million gallons. Backwashing is performed with sea water, which salts the Zeolite at the same time. The sea water, before use, is chlorinated, coagulated with alum and filtered, the cost of this, including pumping, being $21.25 per million gallons of sea water, or $8.50 per m.g. of softened water;

Turn to Pages 63-65 for descriptions of helpful booklets and catalogs.

while Zeolite maintenance costs $2.00 per m.g. of softened water. The remaining $3.50 is for pumping raw water through the softeners. Both softeners and sea water filters are automatic in operation.[A6]

Bibliography of Recent Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.
c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article

A *Journal, American Water Works Ass'n*

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1. Cross-Connections in Air-Conditioning Equipment. By F. M. Dawson and A. A. Kalinske. Pp. 1673-1681.
2. Census of Municipal Water Softening Plants in the U. S., Oct. 1, 1937. Pp. 1682-1686.
3. Review of Lime-Soda Water Softening. C. P. Hoover. Pp. 1687-1696.
4. Conditioning of Water Softening Precipitates. By C. H. Spaulding. Pp. 1697-1707.
5. Hollywood's Zeolite Water Softening Plant. By W. A. Smith. Pp. 1708-1711.
6. Sarasota's Automatic Sea Water Regeneration Zeolite Water Softening Plant. By C. E. Richheimer. Pp. 1712-1721.
7. Trends in Zeolite Softening. By S. T. Powell. Pp. 1722-1738.
8. Organization and Preparation of Water Works to Meet Major Catastrophes. San Francisco. By N. A. Eckart. Pp. 1739-1747; Conflagrations. By H. E. Halpin. Pp. 1748-1753; Floods. By E. A. Munyan. Pp. 1754-1756; Tornadoes. By A. R. Davis. Pp. 1757-1760.
9. Dosage of Chlorine in Ammonia-Chlorine Treatment of Water. By M. L. Koshkin. Pp. 1761-1774.
10. Note on the Determination of Chlorine. By T. E. Larson. Pp. 1775-1776.
11. Gold Chloride Permanent Standards for Residual Chlorine. By R. D. Scott. Pp. 1777-1779.
12. The Dynamics of Sedimentation. By J. J. Slade, Jr. Pp. 1780-1802.

D *The Surveyor*

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1. *p.* Water Supply and Town Planning. By G. H. Thiselton-Dyer. P. 699.
2. *p.* Weather and Water Supply. By E. G. Bilham. Pp. 701-702.

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3. *p.* Corrosion of Water Mains and Services. By W. H. J. Vernon. Pp. 741-742.

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1. The Value of a Valve Record. By M. K. Maffitt. Pp. 831-833.

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2. Flood Runoff from Small Areas. By V. H. Cochrane. Pp. 864-876.

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3. Plenty of Good Water at Low Cost. (Cedar Rapids, Ia.) By W. W. De Berard. Pp. 977-980.

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1. More Water for Fighting Fires. By H. W. Taylor. Pp. 1672-1674.

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2. Water for the Fair (New York). By B. Eisner. Pp. 1732-1735.
3. *p.* Expenditure Yardstick for Water Supply Improvements. By E. S. Chase and A. L. Shaw. Pp. 1736-1738.
4. Electric Eye for Automatic Turbidity Control. By G. J. Turre. Pp. 1743-1744.
5. Aerators and Filters Remove Gas and Iron from Well Water. By R. L. Heck. Pp. 1746-1747.

G *Water Works & Sewerage*

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1. The Birmingham Industrial Water Supply System. By A. C. Decker. Pp. 399-404.
2. The Municipality and Its Water Supply. By W. C. Emigh. Pp. 405-408.
3. Coagulation. By J. R. Baylis. Pp. 426-430.

J *American City*

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1. $600 Investment Continues $3,600 Annual Savings. By T. R. Kendall. Pp. 45-48.
2. Control of Hydrants for Filling Street Flushers. P. 69.

K *Proceedings, American Soc. of Civil Engineers*

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1. Economic Pipe Size for Water Distribution Systems. By T. R. Camp. Pp. 1837-1849.

M *Canadian Engineer*

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1. *p.* Developments in Modern Water Supply Practice. By S. B. Morris. Pp. 13-17.

P *Public Works*

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1. Developing a Well by Shooting. By L. A. Smith. Pp. 9-10.
2. *p.* Welding an Aid in Dam Construction. P. 10.
3. Cairo, Ill., Swimming Pool. By C. M. Roos. P. 16.
4. Installing a Flexible-Jointed Pipe Under a Creek. By B. J. Feitelson. Pp. 17-18.
5. "Mud-Flush" Well Drilling in England. P. 18.
6. *n.* Winter Care of Hydrants in Brookline. P. 22.

Leakage Test of a 39-Inch Main

Little Rock, Ark., is completing water improvements which include a filter plant and dam and over 32 miles of 39-inch pipe bringing the water to the filters. It was specified that the pipe line be tested to a pressure 20% in excess of the maximum working pressure, and that under this pressure the leakage would not exceed 150 gal. per mile per day. The line was built of Lock Joint steel cylinder concrete pipe, with rubber gasket bell and spigot joint.

The line was tested in sections so selected that, with the highest point of a section subjected to a pressure equaling or slightly exceeding the working pressure, the lowest point would be 120% of such pressure. Temporary bulkheads were placed at the ends of the section to be tested, and the line filled by pumping through one of these, while air was released at the high points. Then a small force pump equipped with a pressure relief valve was connected and the pressure maintained by pumping in water the amount of which was metered. This metered water was taken as the leakage, although some of it was probably absorbed by the concrete pipe and some due to movement at the bulkheads.

A section 7.3 miles long was tested in April, 1937, and 8.2 cu. ft. was added during 2 hours test, equivalent to 101 gal. per mile per day. In July, a 17-mile section was tested and showed 114.3 gal. per mile per day; and a few days later a section 5.7 miles long gave a test of 173 gpd. per mile. These give an average leakage of 122 gal. per mile, or about 3.1 gal. per inch diameter per mile per day.

The line passes through hilly country and the pressure head on it varies from practically nothing to about 300 ft. Burns & McDonnell are engineers for the work. The Lock Joint Pipe Co., which contracted for the pipe line for a total of $1,562,683, set up a plant for making it in the outskirts of Little Rock, where it turned out as many as fifty 16-ft. lengths a day, laying the first pipe October 2nd, 1936. The total cost of the project will be over three million dollars. It is expected that the new supply will be available early in 1938.

Preventing Freezing of Water Tower Stack

The Concord, N. H., municipal water system contains a 100,000-gallon elevated water tank, fed by a 5-foot stack, and this has frozen solid during several of the coldest winters since it was built. Last year, to eliminate this recurring trouble, a 10-inch pipe was set inside this stack as a feeder to the tank and the space between the stack and the pipe has been filled with coarse granulated cork. The same procedure was followed at another elevated tank of 250,000 gallons capacity.

Municipality's Right to Remove Private Sewer in Street

If an abutting owner's private sewer is so located that it interferes with the paving and macadamizing of the street or the erection of a curb, the municipality may remove such sewer, the Pennsylvania Superior Court holds, Miller v. Borough of New Oxford, 165 Atl. 766, and where the contractor for the construction of a curb removed a portion of the sewer after the owner was requested to remove it or change it and failed to do so, the owner could not require the borough to repair or replace the sewer.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

The Digestion Tank

Turbidity measurement by light absorption is adapted from Glen W. Holmes' method by the manager of the Shipley (England) sewage works. A copper trough 4" long with plate glass ends receives the sewage to be examined, one end being placed close to a photo-electric cell, and light from a projection-type lamp is passed through the trough to the cell. First, however, the trough is filled with distilled water and the apparatus set to read 100 micro-amperes. The corresponding reading when sewage replaces the distilled water is a measure of the difference in transparency between the two. Transparency is not proportional to turbidity and is affected by size of particles, and the sewage sample is emulsified before the test. The instrument can be calibrated by use of turbidity standards using Bentonite. The author believes this method to be as good as any for determining colloidal matter in sewage.[D61]

Flocculation of packing house wastes for 30 minutes before sedimentation greatly increases removal of suspended solids and B.O.D. when clarifier depth is about 5 ft., detention period not less than 80 min., and overflow rate not over 850 gal. per sq. ft. per day. Use of coagulants is unwarranted. Mixed with domestic sewage, can be treated successfully in trickling filters if suspended solids do not exceed 150 p.p.m.[G34]

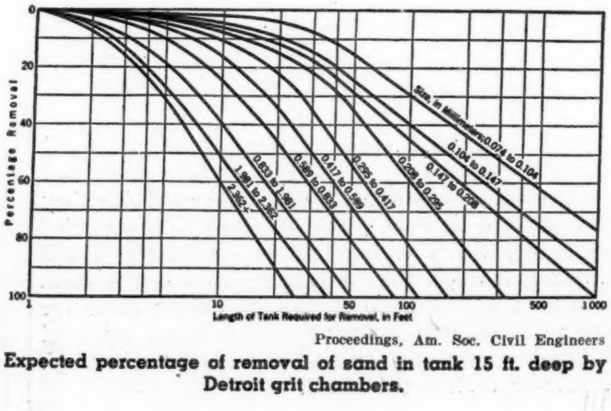
Tank filter is the name given by Dr. Bach to a submerged contact filter provided with artificial respiration. A tank, through which the sewage passes horizontally, is filled with slag, and air is supplied through pipes in the bottom. The sludge is a humus, more readily disposed of than activated sludge and the detention period less than with the activated sludge treatment. It can handle phenol and other sewages that the latter can not. No bulking occurs. As compared to trickling filters, the entire cross-section is effective; and the direction of flow can be reversed. Treating phenols, the waste is diluted so that phenols do not exceed 250 p.p.m; the effective tank volume is 15 cu. ft. per pound of phenols per 24 hrs.; air required is 2500 cu. ft. per pound of phenols; detention period, not less than one hour.[G35]

Grit chamber designing for the Detroit treatment plant was aided by full-scale experiments in tanks at Grand Rapids and Dearborn and use of a small-scale model; the latter to observe flow distribution and the removal of grease and floating material into a submerged conduit. These led to conclusions that "excellent flow distribution can be obtained by means of bar screens having ¾-in. openings. Such screens introduce sufficient loss of head to insure uniform velocity during grit deposition. Grease can be induced successfully into submerged conduits by using a draw-off velocity of 5 ft. per sec. and conduit roofs having slopes of less than 14 degrees." Sand, 8 to 200 meshes per inch, was mixed with water entering the basin and flowing through same at 0.9 ft. per sec., and the amount of each size settling at different distances from the inlet was determined. Particles smaller than 0.2 mm. were considered to be comparatively unimportant. From these experiments a diagram was prepared showing the expected percentage removal of sand, from 0.07 mm. to 2.36+mm., in a tank 15 ft. deep. (See diagram). "In large installations, deep grit chambers proportioned so that uniform velocity conditions exist, are more economical to construct and will perform with the same degree of efficiency as grit chambers of one-half the depth and length and twice the width."[K1]

Concrete sewage structures in the plant at Friern Barnet, England, were subject to damage by the presence of mineral sulphates in dangerous proportions in the clay at the site of the plant. To protect the concrete, a layer 3 in. thick of aluminous cement concrete was placed under all works and up the outsides wherever the concrete would come in direct contact with the clay; and all vertical concrete which would have such clay used as fill against it was covered with a coating of a special tar.[D57]

Raritan river, New Jersey, cleanup is being effected by means of fourteen sewage treatment plants recently completed or to be completed early in 1938, serving a total population of 188,000. Of these, 2 provide sedimentation only, 10 use chemical precipitation, and 2 treat the effluent in trickling filters. The first of these plants was begun in 1934. The combined cost of plants is $2,107,800. All received PWA aid.[E23]

Sludge as fertilizer offers possibilities varying with its origin and nature. Fresh sludge is seldom used. Digested sludge, if wet, must be used near the sewage works; air-dried, may be used perhaps 20 miles away; heat dried, at considerable distance; either wet or air-dried should be plowed under at once. Activated sludge, heat dried, has real value as a source of organic nitrogen fertilizer, free from weed seeds, quickly blending with the soil. Heat-dried digested sludge was prepared in 1937 by only Dayton, O., Rockford, Ill., and Plainfield, N. J. Heat-dried activated sludge is sold readily by Milwaukee, Pasadena and Houston, valuable for its organic nitrogen and phosphoric acid content as well as humus, which may justify a 1,000-mile haul; but cost of preparing it on a small scale confines it to large plants. Heat-dried sludge is safe for agriculture or



Proceedings, Am. Soc. Civil Engineers

Expected percentage of removal of sand in tank 15 ft. deep by Detroit grit chambers.

Installing U. S. Cast Iron Pipe for Sewage Disposal Plant, Providence, R. I.

To make the contingency of repairs an engineering improbability, designers of sewage disposal plants rely on cast iron pipe, its proved corrosion resistance, its great compressive strength and its permanently tight joints. These are equally valid arguments in favor of cast iron pipe for sewer mains—certainly for mains entering the plant. We are equipped to furnish cast iron pipe in a complete range of sizes and standard fittings. Pit cast pipe in diameters up to 84 inches—Super-de Lavaud *chill-free* centrifugally cast pipe in diameters, 24 inches and under. Stocks carried at 15 shipping points.

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horticulture from the hygienic standpoint; and air-dried digested sludge if plowed under and used like manure; while fresh sludge is but a step removed from night soil in its bacterial hazard.[E1]

Boston harbor pollution by sewage from the 1,960,000 people in the Metropolitan Sewerage System has been studied by a special commission which finds objectionable conditions from sleek and floating matter; at no point was dissolved oxygen less than 50% saturation, and the highest B.O.D. was 4.1 ppm. Water in various areas contains large numbers of sewage bacteria and is dangerous for bathing. Objectionable conditions can be removed by removing certain suspended material and grease and chlorinating the settled sewage, or by carrying outfalls beyond the harbor by tunnels, first removing grease and floating materials. The tunnels would cost $26,100,000; but more economical would be providing treatment works at the 3 main outlets (bar screens and sedimentation tanks with skimming and sludge-removal equipment) sludge to be barged to sea, followed when necessary by a program of progressive tunnel development. The latter (not including tunnels) plus capitalized cost of operation to 1955, is put at $32,500,000.[L1]

Pumping unscreened sewage should be avoided, said F. E. Daniels, discussing the plant at Coatesville, Pa., where vertical centrifugal 2,100 gpm pumps had to be taken out of service for cleaning at not infrequent intervals. "Effective screens in ahead of the pumps will save a lot of grief to the operator." Raw sludge is raised from sumps by diaphragm pumps, the ball valves of which occasionally clog partially or completely.[C72]

Heating sludge before it enters the digestion tank is practiced at Coatesville, Pa. by passing it in series through 76 4" tubes 14 ft. long. contained in a boiler the water in which is heated by gas, the sludge taking about 15 minutes to pass through and being heated to 80° to 85°. Sludge enters the heater at the bottom and leaves at the top while the water moves in the opposite direction. This same water is passed through heating coils in the digestion tank.[C72]

Sludge gas is compressed, at Green Bay, Wis., to 10 to 30 lb. per square inch, in a Hortonsphere (a steel tank spherical in shape) 50 ft. in diameter. "Storage of gas is just as necessary for efficient plant operation as the storage of water is for efficient water power operation. The first time sewage gas was compressed and stored was at the plant at Kohler, Wis., which has a 10,000 cu. ft. underground storage gas tank."[H1]

Sewer maintenance in Lower Merion Township, Pa., includes flushing the entire system once a year, dragging sewers that need it, keeping manhole covers in proper shape, building new manholes and general repairs. Flushing is by means of a 625 gal. steel tank on a truck discharging through a 6" vertical gate into a manhole, tank being filled from creeks by gasoline pump with 2" suction hose; crew, truck driver, foreman and laborer. Sticks, stones and other solids removed from sewer before flushing. Cost, including truck and pump depreciation, insurance, gasoline and repairs, was $693 in 1936, or $5.89 a mile. Cleaning is done with a "Champion" outfit.

Noisy manhole lids are remedied by use of an asbestos gasket on the seat. To prevent mischievous removal of lids, sewer joint asphaltic compound is poured into

annular space between frame and cover at three or four points. Manhole steps are made of wrought iron heavily galvanized.[C73]

Precipitation of settleable solids may, with a dilute sewage, give an effluent that needs little further treatment if the sewage is fresh and has absorbed a minimum of decomposition products. This suggests the use of the smallest tank that will remove these solids, giving the briefest practicable flowing-through time, and continuous removal from the tank of solids and scum—or at least removal at sufficiently frequent intervals to prevent putrefactive action. Giving a long sedimentation period may result in an effluent containing more objectional matter in solution than would be carried out by the fine suspended matter that had not settled in a short period. The fine unsettled matter can be removed by floculation (aided by chemicals when this alone is not sufficient) and final sedimentation. "The methods which are being so largely adopted in America should certainly have their uses in this country" (England).[D2]

Bibliography of Recent Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article

D *The Surveyor*

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1. *p.* Efficiency of Humus Settling Tanks. By P. G. Lloyd. Pp. 621-623.
2. *p.* Occurrence of Dilute Sewage and Its Rational Treatment. By H. C. H. Shenton. Pp. 629-630.
3. *p.* Design of Sewage and Storm Water Pumping Stations. By E. V. Bevan and B. T. Rees. Pp. 647-648.
4. *p.* Sewage Treatment Methods and Problems. By W. H. Makepeace. Pp. 671-672.
5. *p.* The Design of Sewers. By W. M. Ogden. Pp. 687-689.

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6. *p.* Elimination of the Detritus Dump. By C. B. Townend. Pp. 735-737.
7. *p.* Seventeen Months' Operation of Activated Sludge. By W. T. Lockett. Pp. 739-740.

E *Engineering News-Record*

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1. Sewage Sludge as Fertilizer. A. P. H. A. Report. Pp. 906-907.

G *Waterworks & Sewerage*

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1. Ferric Chloride Treatment at El Paso. By C. D. Yaffe. Pp. 409-412.
2. Sludge Gas Power on Sewage Works. By J. D. Watson. Pp. 438-440.

H *Municipal Sanitation*

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2. Sanitation Research Laboratory Opened at N. Y. U. By L. V. Carpenter. Pp. 616-618.
3. Sewage Plant Operation: Effluent Disinfection and Odor Control. By W. H. Wisely. Pp. 619-622.
4. New York State Licenses Sewage Works Operators. Pp. 623-624.
5. Wards Island Sewage Treatment Project. By W. D. Binger and R. H. Gould. 627-630, 636-637.

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2. Street Cleaning in Boston. By A. J. Post. Pp. 65, 67, 69.
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4. Automatically Cleaned Bar Screens; Their Care and Operation. By H. F. Watson. Pp. 79, 81.

K *Proceedings, American Soc. of Civil Engineers*

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1. Grit Chamber Model Tests for Detroit, Mich., Sewage Treatment Project. By G. E. Hubbell. Pp. 1867-1882.

L *Civil Engineering*

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Charging for Sewerage Service Outside City Limits

Methods and rates adopted by cities for charging for such service

"WHAT bases of payment can be applied and what charges are made by municipalities for the use of its sewerage system by individuals and communities outside the city limits?" This is in effect the question submitted to the International City Managers' Association by officials of a number of cities. The reply, published in the Association's organ "Public Management," is as follows:

The first step is to determine the total cost of operation of the sewerage system for the period adopted, including the proper proportion of the cost of construction, operation, maintenance, and treatment. The problem then is to apportion this cost equitably between the city and the outlying communities connected to the sewerage system. Is the outlying community an incorporated place? Does it, or does the city, construct and maintain the lateral sewers in the outlying community? Is the water metered? These and other factors must be considered in determining the basis of the charge.

Methods of Determining Charges

Perhaps the most equitable method for apportioning the costs is the volumetric basis. If the outlying community is an incorporated place and its sewage is discharged into the city's trunk sewer at one or two points, then it is relatively easy to measure the volume of sewage contributed by the outlying community by means of a venturi meter. The proper share of the total cost of construction, maintenance, and treatment would be apportioned in the ratio of the volume of sewage contributed by the outlying community to the total volume of sewage treated. By the phrase, "proper share of the total cost," is meant that there should be taken into account only the construction cost and maintenance charges which can be fairly attributed to the outlying community. The capital cost for construction and the cost of maintenance in operation may be computed on different bases. Also, no part of the maintenance cost for the laterals in the city would be charged to the outlying community, for example, unless it made use of them. Another basis which may be used for distributing the total cost is to apportion it on the ratio of the number of miles of lateral sewers in the outlying community to the combined mileage of laterals in it and the city.

Either of these methods places full responsibility for collecting the individual charges upon the shoulders of the officials of the outlying community. The city of Louisville has made use of a scheme, prorating the total cost for use of its sewerage system, even though the outlying community is unincorporated. This was accomplished by the formation in the outlying community of an association which assumes the responsibility for collecting the individual fees. It should be emphasized that the individual property owners, rather than the association or its officers, signed the agreement with the city.

Still another solution would be the creation of a sanitary district. State laws permitting, such an agency is created to provide the desired sewerage service for the district which generally includes a municipality and its surrounding region. The officials of the sanitary district are charged with the full responsibility for providing satisfactory service. They are authorized to incur debt independently, and they are granted full taxing powers to produce the funds necessary to operate the sewerage system.

If the outlying section is unincorporated territory and it is necessary for the municipality to collect the fees from the individual property owners, other bases of charging must be employed. The following bases are in use: (1) metered water consumption; (2) metered water consumption with minimum bill; (3) water bill, a fixed percentage of; (4) number of plumbing fixtures; (5) type of property; (6) number of persons; (7) number of sewer connections; (8) number of water connections; (9) uniform rate for all users.

A fee based on the metered water consumption probably would result in a reasonable distribution of the costs. Of course some differentiation would be made in rates between ordinary households and commercial establishments such as laundries, for example. This method requires that water supplies be metered and therefore expediency rather than scientific principle frequently dictates which basis is selected.

Practices in Six Cities

The variation in the bases and the amount of the rate charged communities outside the city limits is illustrated by the practice in six cities:

PHOENIX, ARIZONA (78,000 people served).—The basis of the charge, which includes the cost of treating sewage plus the proportional cost of sewer system construction and maintenance charges, is on metered water consumption, minimum bill, and type of property. The rate is 7 cents per 1,000 gallons of sewage based on metered water consumption; $1.50 monthly minimum bill per house where not metered; and 25 cents per month per cabin in auto courts.

GREELEY, COLORADO (12,203).—The basis of charge is a uniform levy per sewer connection at the rate of $3 per year.

ELIZABETHTOWN, KENTUCKY (2,000).—The charge is based on the type of property. Monthly rates are $1 for residences; $1.50 for apartments, stores, and offices; $2 for hotels with less than 30 rooms, $4 for more than 30 rooms; $3 for public garages; $2.50 for public schools; and $4 for manufacturing plants employing more than 30 people.

ANN ARBOR, MICHIGAN (38,000).—The basis of charge is the metered water consumption with minimum rate. The rate for the first 1,500 cubic feet is 8¾ cents per 100 cubic feet; next 98,500 cubic feet at 5¼ cents per 100 cubic feet; and over 100,000 cubic feet, 3½ cents per 100 cubic feet. The minimum rate is 75 cents per quarter.

HICKORY, NORTH CAROLINA (13,000).—The basis of charge is the percentage of water bill and minimum charge. The rate is 75 cents per month minimum, plus 15 per cent of water bill in excess of $5.

TAYLOR, TEXAS (6,500).—The basis of charge is the number of rooms and number of fixtures. The rate for a four-room private residence is $3 per quarter minimum, ranging up to $3.75 per quarter minimum for a six-room house. These rates apply only where there is one set of fixtures; extra charge is made for additional fixtures at residences, such as, for each additional water closet, 75 cents per quarter. A special schedule of rates is set up for facilities in stores and restaurants. For example, the rate for a water closet in a store is $3.75 per quarter, and for auto wash rack catch basins $5 per quarter.

Broken Hydrants—a Drain on Taxpayers' Pockets

By HOWARD LAW

A FEW weeks ago, passing a busy corner of one of our large cities, I saw a perspiring group of laborers (perhaps they should be referred to by the more dignified name of repair crew) digging through a jaggedly broken cement sidewalk and tossing yellow clay onto a growing pile, as they excavated to get out a fire hydrant that some carelessly driven automobile or truck had smashed.

Two days later, when I passed there again, the same crew of men were recementing the sidewalk, and a new hydrant stood there with a sign slung over its shoulders reading "wet paint." And I began to think over what I had observed. Obviously, it had taken at least three part-days, possibily three full days, of the crew to repair the damage. They had to have a tool-wagon and tools. The tool-wagon had to be hauled to the job, from where? Broken parts had to be replaced. For all of which the city probably paid.

So what? Was the vandal who did the damage apprehended and made to pay for it, or did he get away? Or did the cost of repairs come out of the pocket of the city? What grave results might follow if there happened to be a fire near that hydrant during the time that it was out of service? Are the taxpayers in the vicinity of a broken hydrant getting a square deal when their lives and properties are without the fire protection which depends upon that hydrant?

How extensive a by-product of traffic accidents is this breaking of fire hydrants? I decided to ask the question of a number of large cities, and quote here from several of the letters received, giving figures on hydrant damage by traffic accidents last year, and repair costs:

Of fourteen cities which furnished their 1936 figures on the number of hydrants broken, the greatest number in any one city was 251, the smallest 29. The cost of repairs ranged from a low average of $14.58 to the amazing figure of $135.59 per hydrant. The total for the fourteen cities was 1460 hydrants, and the cost $78,208.58—a by-product of traffic accidents (mostly avoidable) that taxpayers have to stand for.

A broken hydrant, and digging to replace it

Chicago: "There were 130 fire hydrants broken or damaged (in traffic accidents) to such an extent they required repairs or replacement and the total cost of same amounted to $17,626.87."

Detroit: "Please be advised that in 1936 there were 75 hydrants broken in Detroit and same were repaired or replaced at an average cost of $75 each or about $5,250."

Los Angeles: "The records of our claim department show that, during the fiscal year July 1, 1936 to June 30, 1937, files were opened for 221 cases of damage to fire hydrants known to be caused by automobiles. In 103 of these cases approximately $2,100 was collected from auto owners. In 65 cases involving approximately $1,250 expense to this department no collection was made. No collection was attempted in 35 cases because practically no repair expense was incurred, and 18 cases are not closed.

In addition to the above, the maintenance crews occasionally find damages to fire hydrants that must have been caused by collision, but were not reported. There are approximately 30 such cases a year, involving an expense estimated to average $10 each."

New Orleans: "During the past year in New Orleans 93 hydrants were broken or damaged, cost of repairs being $3,650.25. We were not able to recover over 20% of this damage."

New York City: "In the Borough of Manhattan there were 13,026 standard hydrants in service on January 1, 1937. This does not include the hydrants of the High Pressure Fire System.

During the year 1936, 152 of these hydrants were broken by being struck by trucks.

Some were broken by trucks backing over the sidewalk to reach a loading platform at the building line, and some were due to skidding. Our records do not differentiate and, in most cases, responsibility is difficult to place.

The cost of excavation, placing a new standpipe or welding the old one in place will average under $50 each over the year."

Philadelphia: "The total number of hydrants broken during the year 1936 through collision by automobiles was 212 and an approximate cost for their replacement was $13,340."

Seattle: "The city of Seattle has approximately 10,000 hydrants in use, and we average about four traffic accidents a week, or a total of some 200 a year. The cost of repairing these hydrants varies from $10 to $125, depending upon the amount of damages incurred and the degree of impact of motor vehicles upon the hydrant when the collision occurred.

We recover approximately 80% of these damages, largely through the medium of insurance maintained by the owners of the vehicles concerned. The police department cooperates with us, impounding the automobiles until satisfactory arrangements with reference to costs of repairs have been made with the city. Unfortunately, however, numerous collisions occur in which the owner of the vehicle gets away leaving no trace, because his vehicle is not sufficiently disabled to be impounded, and we find through periodic inspection of the hydrant, that it has been damaged."

St. Louis: "Throughout the fiscal year, April 1st, 1935, to April 1st, 1936, 79 fire hydrants were broken by autombiles, of which the drivers were apprehended in 54 cases; in 25 cases the party who did the damage could not be located.

The cost of repairing the damage where the driver was not located amounted to $780.65; the cost of repairing the damage in cases where the driver was apprehended amounted to $1,909.76, but of this amount we have been able to collect only $984.97, so

that the Water Division has been to a net expense of $1,705.44 on account of broken fire plugs."

It is evident from the above that the replacing of broken hydrants is an expensive procedure. In order to reduce the expense and time involved in repairing such breaks, several manufacturers make hydrants that are purposely weak in one section, so that, if they break, it will be in a certain place just above ground level, so that a service crew will not have to excavate in making a repair or replacement. There is also another type of hydrant in which the top part unscrews from the bottom, so that, if damaged, the entire barrel can be pulled out and a new one screwed in, the complete replacement being made in a few minutes, while the broken section is taken to the shop for repair, and parts not harmed are salvaged and stored for future use.

Getting into this fire hydrant subject raises all sorts of interesting questions, such as what happens to hydrants in cities and towns that have really cold winters. The danger of their being put out of commission by freezing is not the only one. In heavy soils which pack solidly, the freezing ground, as it expands, grips the hydrant barrel and exerts an upward pressure, which may crack the elbow at the base of the hydrant. Some cities go to considerable expense each winter to prevent this destructive frost action, as by leaving a chamber around the hydrant barrel which they fill with straw or manure to prevent freezing and upheaval. In one type of hydrant a sheath of iron is provided which, if gripped and pushed up by frost action, merely slides up the hydrant barrel, and so no harm results.

An interesting sidelight on fire hydrants is that of how they got the slang name of "fire plug." In fact, it is not a slang name at all, but the real name of the historic ancestor of our modern hydrant.

In the early days, when water mains carried little pressure and were generally made from bored logs, provision for getting water up out of the underground pipes for fighting fires consisted of boring holes in the pipes at certain places, and stopping up those holes with wooden plugs. The locations of these plugs were marked, and, when necessity arose, the firemen dug a hole at the site of the plug and knocked out the plug, following which the hole would fill with water, which was then scooped out with buckets by the bucket-brigade. Later, with the development of fire pumps, the end of a hose was held in the hole, the pumps manned and water squirted on the fire.

One more suggestion relative to fire hydrants: *Why* is it so necessary that hydrants be set out at the curb, where they can be easily backed into by long-bodied trucks or crashed into by unruly motor cars? Firemen tell me they rarely use the hydrant that is menaced by the walls of a burning building, preferring to attach hose to hydrants a slight distance away for greater safety and better control. So, why not set hydrants back near the building line, even though doing so would mean laying a longer connection from the water main? This at least would make hydrants less accessible to the traffic accidents.

Cold Weather Precautions for Elevated Tanks

By F. O. MALLOY

The most important part of a water supply tank is the riser that connects the mains with the water reservoir or the tower. This may be discussed in three separate parts—the expansion joint, the riser pipe, and the frost casing.

The expansion joint is the only moving part of the tank and must be lubricated as every moving part has to be. This packing must provide for movement and at the same time must be water-tight against pressure. The riser pipe must be in true alignment with the tank so that it can move freely in the packing gland. Some causes for leakage at expansion joints are: old, dried out packing, an insufficient amount of packing, and material of the wrong type. Frequent inspection and maintenance of this part of the elevated storage tank is necessary, especially before freezing weather sets in. A water-soaked frost casing resulting from a leaky expansion joint will freeze and not provide the necessary insulation. Leakage in the riser pipe itself also should be guarded against and stopped with such repairs as may be necessary.

If the frost casing is equipped with a heating system, inspect it carefully. Steam and hot water pipes are subject to scaling, thereby reducing the heating capacity. In frost casings depending upon insulation material to prevent freezing in the riser, the keeping of this material in a dry condition is essential. Larger diameter risers (5′ or 6′) without insulation are more subject to freezing than the smaller diameter if insulated. This is especially true where the consumption and pumping rates are low, as the movement of water must be depended upon to prevent freezing. Where these risers are equipped with heating devices, during severe cold weather it is well to keep the water level down, as you can not heat a tank full of water sufficiently to keep it from freezing, but you may be able to heat the quantity of water contained in the riser. A riser full of water is more fire protection than a tank full of ice.

Freezing in the tank proper can be controlled only by the movement of the water in the tank and depends upon the consumption rate and the rate of pumping. The larger the consumption and the faster the rate of pumping, the less ice one has to contend with. If the riser pipe does not extend into the tank farther than the thickness of the ice that forms on the bottom of the tank, this riser may freeze over across the top. In many cases this has happened and the tank has been blamed for freezing solid, which was not the case. However, if this riser freezes, then the water in the tank may likewise freeze solid, depending upon the time of exposure.

The water storage space in the tank should be free from all obstructions. The spider rods must be drawn up tight and must be above the maximum water level. If the water reaches as high and freezes around the spider rods, trouble is certain. The ice will melt from the edges first and if sufficient ice is present the weight may break the rods, destroying them and the roof. This trouble may be eliminated by use of the proper type of overflow. The overflow should not be less than 3″ in diameter, should look downward, and should be provided with a screen to prevent anything entering the tank through it. Proper size of overflow may be determined by the capacity of pumps and the size of the tank.

Further protection against freezing of both the riser and the tank may be gained by pumping nights and letting the normal consumption take care of the water movement during the day. Leaving a large faucet or hydrant running at night when not pumping will also help.

It is interesting to note that aluminum painted tanks freeze much more than do tanks painted black—*"The Clarifier," bulletin of the South Dakota State Board of Health.*

Remote Control for Small Pumping Stations

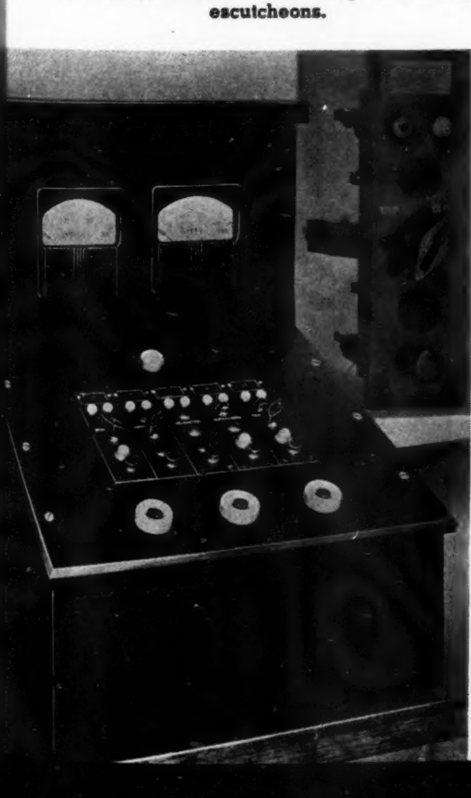
POLARICODE, JR. is a simplified supervisory control system designed especially to provide economical remote control for water works pumping stations which formerly did not justify the expense of the previous higher-cost supervisory systems. It utilizes the fundamental principles and basic elements of the larger Polaricode system and is capable of performing all the various operations of control, supervision, and position control associated with previous Westinghouse supervisory systems. It will control remote apparatus over a distance of 40 miles using No. 19 gauge copper wire.

Polaricode, Jr. is available in one size only, which is definitely limited to, and equipped for, a total of five selective, complete operations, thus making it possible to reduce the amount of apparatus required and still meet the requirements of the average small pumping station.

Only two line wires similar to those used for telephone purposes are required between the dispatching office and each remotely-controlled station. No extra line wires are required for selective telemetering indications. Continuous, individual lamp indications are provided for supervising the position of each remote apparatus unit.

The control is designed to provide protection against the possibility of false operation of any controlled apparatus unit due to foreign voltages on line wires, such as might be caused by induction from high tension lines or by lightning.

Dispatcher's equipment for Polaricode Jr. Supervisory Control. Upper panel provides space for mounting remote metering receivers. Inset — One of the key and lamp escutcheons.



The dispatcher's control operates in a manner similar to that in which an operator in the remote station itself would control the apparatus by means of the usual local control.

A key and lamp escutcheon is provided for each pump or other distant unit. Pulling the selection key on an escutcheon causes the dispatching office relays to set up and place on the line wires a predetermined selection combination, each escutcheon having its own combination differing from the others; and this causes the corresponding selection relay at the remote station to energize. This in turn sends a selection combination back to the dispatcher's office and lights the selection lamp on the same escutcheon, checking the correctness of the selection. (Unless the selection checks back correctly, the dispatcher cannot operate further and the equipment is returned to normal by pushing in the selection key.)

The operation described assigns the desired escutcheon to the line wires at the dispatcher's end and the corresponding interposing relays to these wires at the remote station. The dispatcher can then either start or stop the corresponding pump by turning the twist-type control key on this escutcheon to the "start" or "stop" position, as the case may be, and then depressing the master control key, which causes the dispatcher's relay equipment to set up and place on the line wires the "start" or "stop" operation combination, which in turn causes the remote station relays to operate the corresponding interposing relay, which completes the local control circuit and causes the pump to start or stop.

At the completion of the starting sequence, the position of the auxiliary switch of the running breaker changes, which in turn causes the remote station relays to set up and place on the line wires a combination similar to the one originally sent by the dispatcher's office to start the pump, which operates the dispatcher's relays to change the indicating lamps on the escutcheon from green to red (from red to green when the pump is stopped). The selection relays are then released and the equipment restored to normal by the dispatcher pushing in the selection key.

Briefly, to start pump No. 1 the dispatcher pulls out the selection key at the bottom of escutcheon No. 1, turns the control key on this escutcheon to its "start" position and then depresses the master control key, and pushes in the selection key when the red light at the top of this escutcheon goes on.

Each selection is automatically and positively checked, and must be correctly completed or no further operation can take place. The control and supervision combinations are so arranged that it is virtually impossible to duplicate them by external sources of interference such as induction from nearby high tension lines or by lightning. This guards against wrong selection or false breaker operation due to foreign voltages on the line wires from such sources.

A source of 48 volts d.c. is required in the dispatcher's office and in each remotely controlled station. This energy should be obtained at each station from a separate, ungrounded, 24-cell storage battery. It is not recommended that a battery of higher voltage be tapped to provide this energy.

Two line wires are required between the dispatcher's office and each remote station. The maximum resistance per conductor should not exceed 1800 ohms. Line wires of open-type construction, telephone cable or circuits leased from the local telephone company may be used. The wires must be ungrounded and should have characteristics and insulation resistance conforming to the standards of good telephone circuits. The current and voltage requirements are well within the limits set by telephone companies for leased wire circuits.

Heating Time of Highway Materials

It is difficult to state the heating time of materials in a specific number of minutes. It is necessary to consider size and efficiency of the heating equipment, experience of the operator, atmospheric and operating conditions; all have a definite bearing on the final results. In general, however, the following data may help:

Concrete Heater	3 to 4 min.
Concrete Heater with Water Heater	1½ min.
Asphalt (2 drums)	45 min.
Pitch (2 drums)	30 min.
Pipe Coating Enamel (2 drums)	1½ to 2 hrs.
Lead (350 lb. batch)	½ hr.
Pipe Compound: 10 gal. size	25 min.
25 gal. size	60 min.

Note—The above is based on average conditions and figured from a cold start. When heating kettles have become warmed up, the melting time will be reduced from 30% to 50% by putting in cold lumps as fast as hot material is drawn off.—Elbee Tatler.

Public Works Engineering Instruction

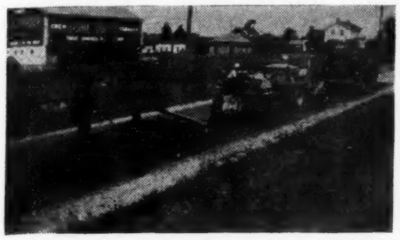
In view of the present and prospective broad activity in the construction of public works, the International Correspondence Schools has prepared a new Public Works Engineering Course to meet the requirements of those who wish to train themselves in the planning, construction and maintenance of public works for cities, counties, states and federal bureaus. The new course has been prepared under the direction of Samuel Baker, C. E., Director of the I. C. S. Civil Engineering Schools.

Turn to Pages 63-65 for descriptions of helpful booklets and catalogs.

Road Show Exhibits and Other New Equipment

New Littleford Units for Road Show

Two new units shown for the first time, the Littleford Motorized Wheeled Roller and the Littleford Surfacing Drag, are to be displayed at the Road Show. Besides these new units, Littleford will show the latest Littleford Model "C" Pressure Distributor, the new No. 101 Utility Sprayer for bituminous maintenance, the No. 84-HD "Double Heat Circulation" kettle and also smaller items such as oil burners, concrete heaters, traffic marking buttons, pouring pots and paving tools.



Right, the Austin-Western new "99" motor grader, described below. Left, the new Littleford surfacing drag for road-mix work. Below, the Littleford wheeled roller at work.

The New Littleford Motorized Wheeled Roller is substantially the same unit as has been marketed heretofore by The Wheeled Roller Corp., of San Antonio, Texas. New improvements include brakes, a water tank and the use of Wisconsin motors.

The Littleford Surfacing Drag will be shown in a working model form, built to scale. The actual unit consists of a framework 24 feet long having staggered rows of plows and a strike-off blade. Built for road mix work, it is used for leveling, resurfacing and wedge courses. It will handle up to 120 lbs. of stone per square yard. It requires a 40 to 60 h.p. tractor.

The Littleford Model "C" distributor will be shown in 1000-gallon size mounted on a White cab-over-axle chassis. The improved No. 101 Sprayer with a new type leakless cocks and swiveling spray bar will be mounted on a Littleford 2-wheeled pneumatic tired trailer, complete with a barrel hoist davit. The Littleford No. 84-HD tar and asphalt heating kettle will be shown equipped with hand spraying attachment and barrel hoist, mounted on a heavy duty round nosed running gear with pneumatic tires.

Three New Huber Machines

The Huber Manufacturing Company, Marion, Ohio, will exhibit for the first time three new machines. A 10-ton Diesel powered roller, a 7-ton "Tru-Plane" roller and a No. 4 Superior grader.

These new 1938 machines will be shown for the first time in space B-7, New Exhibition Hall. To acquaint the visitors with Huber's new equipment, M. E. Miller, sales director, will be assisted by J. M. Miller, Ohio sales manager; G. E. Gifford, chief engineer; G. N. Porter and D. F. Baumgartner, Ohio representatives; and Mr. Newby, president, will also be present.

Armco Road Show Exhibit:

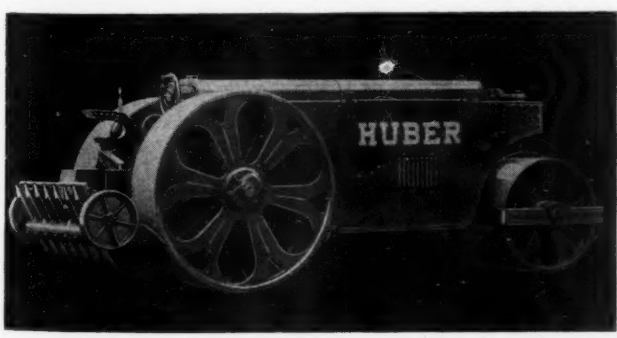
A working model which displays all the various drainage products will be one of the chief items of interest in the exhibit of the Armco Culvert Manufacturers Association. A huge Multi Plate arch, spanning the booth from side to side will be a predominating feature. Other products exhibited will be the new Bin-Type Metal Retaining Wall of special columnar construction, Hel-Cor Perforated subdrainage pipe, and the successive steps in the development of Asbestos Bonded Armco Paved Invert Pipe.

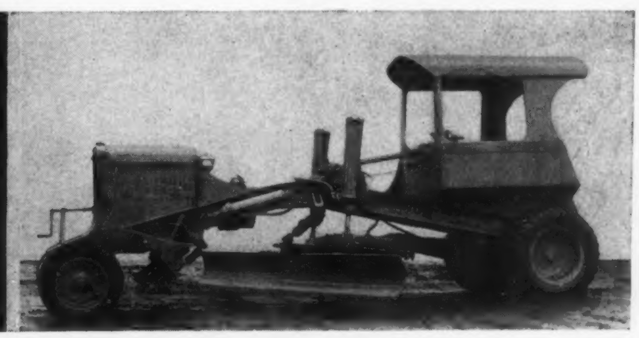
Those in attendance will be S. R. Ives, M. C. Patton, W. H. Spindler, G. E. Shafer, H. E. Cotton, A. J. Grother, C. W. Bean, L. H. Gardner and A. C. Neff.

A New Austin-Western Motor Grader

The new "99" motor grader is to be formally shown for the first time at the Road Show, by the Austin-Western Road Machinery Co. of Aurora, Ill.

The outstanding features of this machine are: power applied to all wheels, and steering through the front and rear wheels whereby traction can be controlled to increase blade output. The





Left, the Huber Diesel roller; right, the new Huber "Superior" grader.

KEEPING UP WITH NEW EQUIPMENT

conventional idling front wheels are not used, but in their place are power-driven front wheels which are the same diameter as the rear drivers. Either single or dual tires may be used. Every adjustment on the machine is controlled by hydraulics, including front and rear steering, extending or retracting the working blade without disturbing position of circle or "floor plane" of road, raising the blade and scarifier, and any other required adjustment.

The "99" is furnished with either gas or Diesel motors, as desired, and optional tire equipment is available. The standard moldboard is 13 feet long. The extra traction and steerability of the "99" enables it to handle a blade of this length on the severest work. The scarifier folds up out of the way to avoid the windrow or load carried by blade.

The machine can be fitted with special attachments such as a scarifier, bulldozer, backsloper, snow plow, wings, etc.

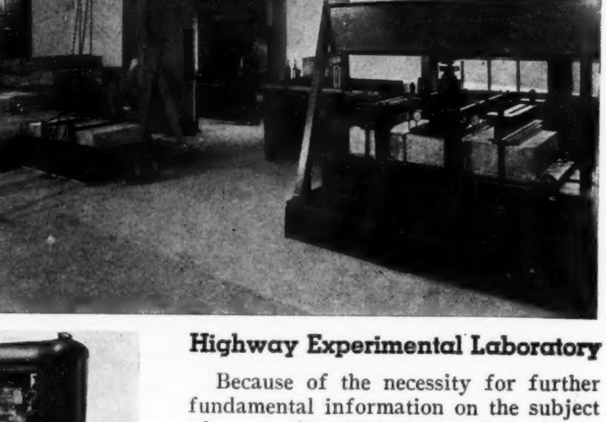
Other new machines, to be announced later, are also scheduled to be on display.

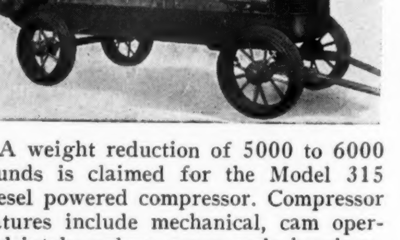
Schramm Inc. Compressors at Road Show

The Model 315 Schramm "Utility" compressor illustrated will be one of the featured items at the Road Show. It is powered by a Buda Lanova Diesel engine and represents a complete line of sizes from 105 to 420 cu. ft.

Sand and cinder spreader of Portable Elevator Mfg. Co., Bloomington, Ill. Hook-up to truck takes 1 minute. For spreading abrasives on ice, or for highway construction and maintenance.

At the right is shown the interior of the new highway experimental laboratory of the Highway Steel Products Co. Below, the Schramm "Utility" Compressor.





A weight reduction of 5000 to 6000 pounds is claimed for the Model 315 Diesel powered compressor. Compressor features include mechanical, cam operated intake valves, seven main bearings, force feed lubrication in both engine and compressor and electric self-starting.

Other Schramm units will include a Model 210 gasoline powered "Utility" Compressor; a Model 105 compressor in two-wheel DeLuxe trailer mounting; and a Model 55 "Fordair" compressor.

H & B Portable Bituminous Mixing Plant

In H & B batch plants, each batch is screened, proportioned, weighed and mixed in a double shaft pugmill with a definite amount of asphalt, which is weighed on a separate scale. This exact control of all material entering into the paving mixture insures the best possible service. The portable plants can be erected by 3 or 4 men in 1 to 2 days. Running gear is not provided on these plants, since it adds to the cost but nothing to the capacity.

Circular T-250 describes this central mix plant which permits concentration of all materials and supervision of all mixing and control operations in one place, with hauling of the finished material to the road. This will be sent on request to Hetherington & Berner, 701 Kentucky Ave., Indianapolis, Ind.; or pick up a copy at the Road Show.

The new Heil hydraulic scraper will be shown at the Road Show.

Highway Experimental Laboratory

Because of the necessity for further fundamental information on the subject of expansion and contraction joints, Highway Steel Products Company, manufacturer of metal fabricated road joints, has recently built and equipped a laboratory to carry on experimental work on this subject in collaboration with the work done by the individual Highway Department testing laboratories and other research organizations.

J. W. Kushing, who is vice-president of the company, was formerly Research and Testing Engineer of the Michigan State Highway Department; he has had considerable experience in research on concrete pavement joints and is in charge of the laboratory and research work. It is the hope of Highway Steel Products Company that further information can be gained through work on the subject of stresses in concrete slabs at joints.

In addition to road joints, the new laboratory is equipped to test other road materials manufactured by the company. The illustration shows the machine used to test load transfer devices in expansion joints and the method of handling test specimens.

Mall Concrete Vibrators

The Mall Tool Co. exhibit at the Road Show will consist of gas engine, air and electrically operated concrete vibrating and surfacing machines; also, the various attachments which can be used on these machines, such as chain saws, sump pumps, hand saws and drills.

Mall vibrators are immersed directly into newly poured concrete, compacting it firmly against the reinforcing steel and forms, and eliminating aggregate pockets and honeycombs. All the attachments can be used on one unit. It is not necessary to purchase a separate power unit for each application.

Water Well Drill

The Bucyrus-Erie Company, South Milwaukee, Wisc., has issued a new bulletin, 21-W-2, covering the Bucyrus-Armstrong 21-W Water Well Drill. Field action photographs; pictures; and a complete story. Copy on request.

KEEPING UP WITH NEW EQUIPMENT

New Koehring Equipment:

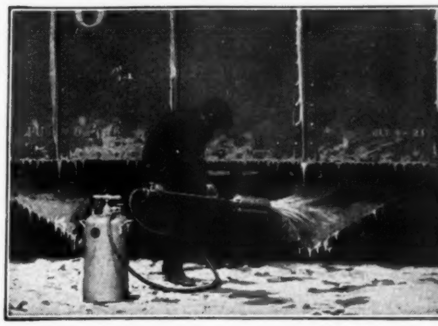
Koehring equipment to be shown ranges from excavators for large construction jobs to small concrete mixers for the sidewalk job. Included will be the Dumptor and Trail-Dump, the Dual Drum 34-E Paver, the Longitudinal Finisher, the Mud-Jack, and various sizes of concrete mixers.

Outstanding among the Koehring developments is the Dual Drum 34-E Paver, the latest contribution by Koehring to highway paving progress. Contractors have been able to increase yardage from fifty to ninety per cent, with a slight increase in auxiliary equipment, over a standard 27-E single drum paver. The Dual Drum 34-E has a 25% greater batch capacity and based on a one-minute mix, can produce over 80 batches per hour. Contributing factors to high production are the non-clogging transfer chute supported outside of the drum, pneumatic operation of the discharge and transfer chutes, and the 35-foot boom which greatly facilitates the spreading of the mixed concrete. Automatic control of the batchmeter and the skip maintains a high speed, synchronized cycle of batches per hour.

New excavator models are the Koehring 303—a ¾ yard Shovel—and the 603—a 1½ yard Shovel. Both have anti-friction bearings and enclosed gears running in oil and are quickly convertible for Shovel, Dragline, Crane or Pull Shovel operations. A handy Transport Trailer on exhibit with the Koehring 303 Shovel greatly facilitates moving from job to job. Loading and unloading time has been reduced to a minimum. Job to job moves are quickly made and non-productive travel time is translated to profit time.

The Mud-Jack, used for raising depressed highway slab, has been completely redesigned for 1938. Improvements are streamline design, new non-clogging discharge valves, free passage mud piston and inlet valve.

Other equipment on display, including Dumpers, Trail-Dumps and Mixers, is exhibited with their latest improvements.



Littleford Torch thawing an aggregate car.

Calcium Chloride

The Calcium Chloride Association exhibit will dramatize the year-round use of calcium chloride—in stabilization, dustless maintenance, concrete curing and ice control. Of particular interest to maintenance engineers will be a new bulletin on surface consolidation of gravel roads through addition of clay and calcium chloride.

A walkway of calcium chloride stabilized material, constructed on the exhibit floor, will give visitors an opportunity to examine an actual stabilized surface. Complete data and consulting service on methods and equipment for the production of plant-mixed stabilized material will be available to aggregate producers and to highway officials interested in setting up mixing plants.

Ray Giddings, Fred Burggraf, Charlie Tiney and Bob Fosburg will all be at the show.

Sterling Crankless Diesel Engine

Engineers will be interested to know that the Sterling Crankless Diesel engines are now in production. This Diesel engine is a horizontal engine, employing 4 cylinders with 8 pistons working parallel to the main shaft. The power is delivered from the pistons through a Michell or Kingsbury Thrust Bearing to an inclined power disc, which is rigidly fixed at an angle to a straight shaft. There has been eliminated cylinder heads, cylinder head gaskets, valves, camshafts, springs, rocker arms and tappets. The advantages gained by the absence of these working parts are manifold.

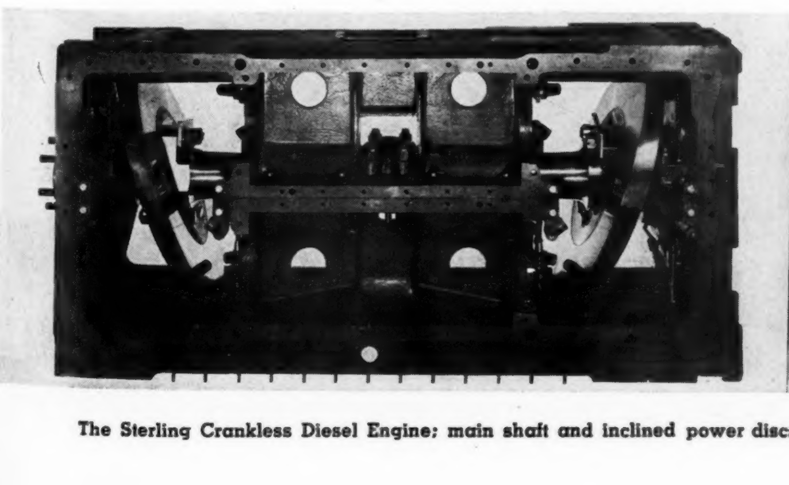
Pistons and connecting rods move horizontally. There is no angular motion to the connecting rod, which reciprocates in a straight line without any side pull on the piston; thus, the pistons are allowed to center in the cylinder, and their action does not disturb the piston rings. This principle adds to good combustion and naturally increases the life of piston rings. Since Diesel engines work under an initial compression of the air at 500 pounds and much higher combustion pressures and at higher heats than gasoline engines, this is important.

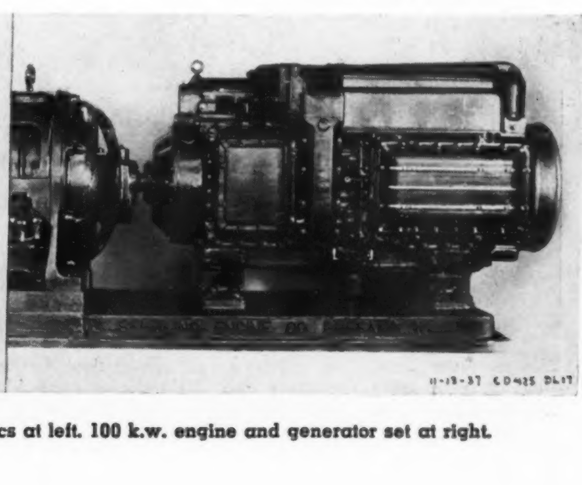
Electric starting is accomplished by a 32-volt starter, with a double throw switch. The first position of the starter switch employs 12 volts to engage the Bendix gear. The second position employs the full 32 volts to rotate the engine, and starting is rapid, since there is no cold surface, such as the inner side of the cylinder head, to interfere with the building up of the heat necessary to provide good combustion.

Due to the 2-cylinder principle, combustion at every outward stroke assures proper constant heat, and heat of combustion is solely employed to ignite the charge. Uniformity of this heat is ultra desirable in any Diesel engine. The combustion space is comprised only of the space between the 2 piston heads—there being no pockets or heated elements of any kind.

The engine is entirely free of vibration, and needs only the same type of engine bed that would be adequate for a gasoline engine. It has all the operating characteristics of the gasoline engine in speed range, but, of course, runs on the lower cost Diesel fuel oil—No. 2 fuel oil being recommended. The engine speed may be transposed from 1200 revolutions per minute to 1000 or 800 or 600 or 520 R.P.M., with various stock ratios by means of built-in reduction gears.

The current model is a 4¼" bore, 5.45" stroke engine, with a rating of 135 horsepower at 1200 R.P.M., and with overload capacity and a marine rating of up to 150 horsepower. There is now under construction a 6½" bore, 8½" stroke, engine of identical characteristics, with an intended rating of 350 horsepower at 900 R.P.M.





The Sterling Crankless Diesel Engine: main shaft and inclined power discs at left. 100 k.w. engine and generator set at right.

KEEPING UP WITH NEW EQUIPMENT

A pocket-size instrument for determining quickly the presence of combustible gas. Shows if gas concentrations are within explosive range. Carried in pocket or on shoulder strap. Copy of booklet explaining this in detail sent on request to editor of this magazine.

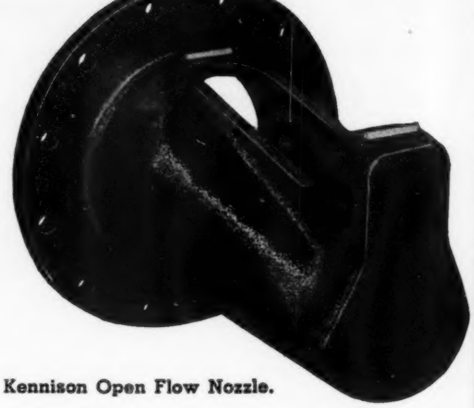
U. S. Steel Road Show Exhibit:

The United States Steel Corporation Subsidiaries will present dioramas portraying the following products and features:

I-Beam Lok armored bridge flooring; bearing piles; sheet piling; concrete reinforcing bars; culvert sheets and plates; wire fabric for concrete reinforcement; American electric wires and cables for use on shovels and other road building equipment; multisafty highway guard; Universal Atlas white portland cement for road markers; Atlas white portland cement for general road construction; erection of bridges, overpasses and other road structures as fabricated by the American Bridge Company; and, a composite diorama showing an overpass in cross section.

In the background of the exhibit space, which covers an area of 1080 square feet, will be a mechanical diorama in which a moving highway scene will demonstrate USS Products as safety features in highway construction.

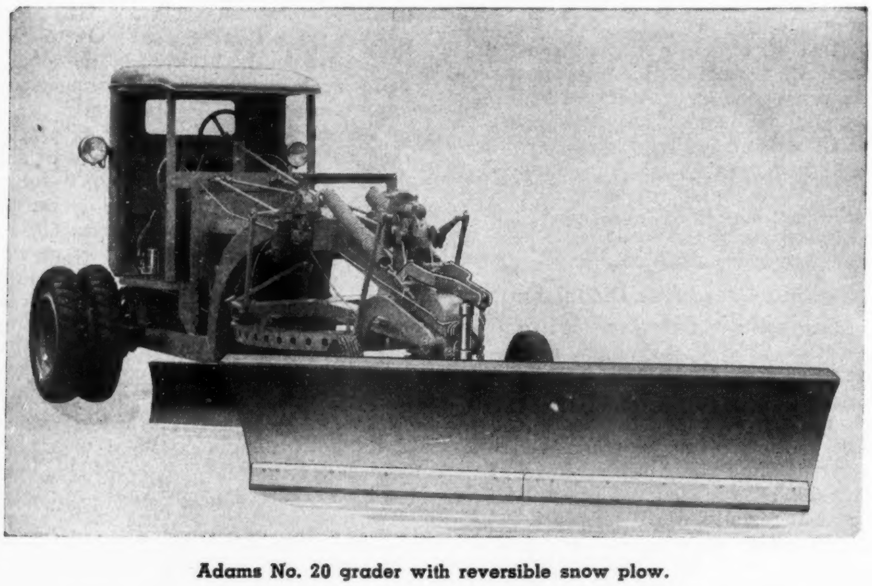
The subsidiary companies represented will include: American Bridge Company; American Steel and Wire Company; Carnegie-Illinois Steel Corporation; Columbia Steel Company; Cyclone Fence Company; Scully Steel Products Company; Tennessee Coal, Iron and Railroad Company; Universal Atlas Cement Company.



Kennison Open Flow Nozzle.

Kennison Open Flow Nozzle:

This is the first printed material describing this device for measuring the flow of sewage (or other liquids). The nozzle is an open pipe end contracted so that the flow of liquid is registered. It is described in Bulletin 289, available on request from Builders Iron Foundry, Providence, R. I.



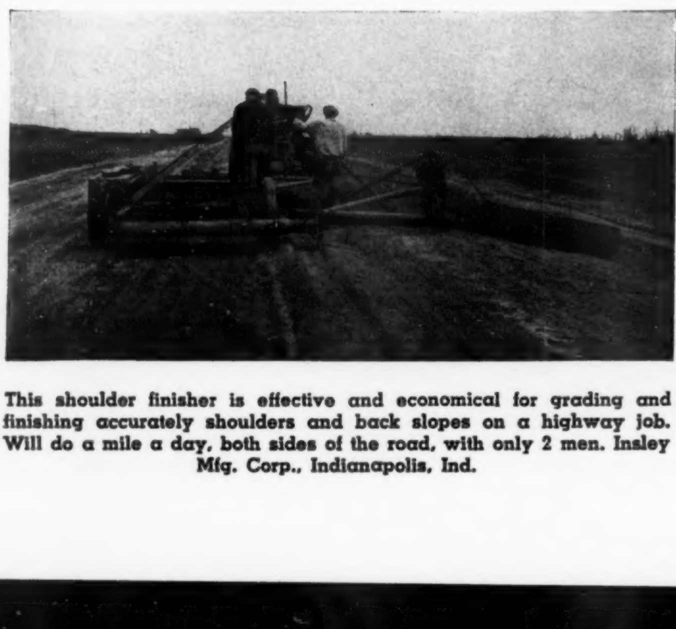
Adams No. 20 grader with reversible snow plow.

A Grader for Municipal Work:

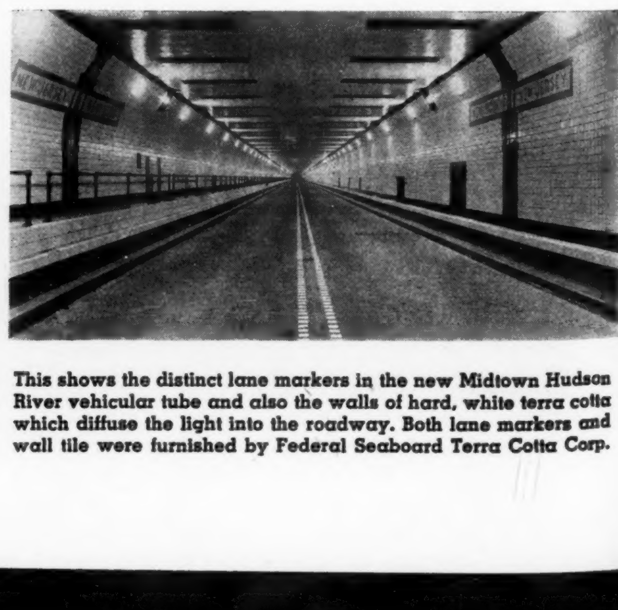
Designed especially for municipal work is the new Adams No. 20 motor grader. The makers say that they have designed the finances of it also to fit municipal pocketbooks. We don't know about that because we haven't information on this phase of the problem, but our readers can find out easily enough by writing to J. D. Adams Co., Indianapolis, Ind.

It has been designed for maintaining unimproved streets and alleys; for grading and maintaining roads and runways in parks, golf courses, air ports, etc.; and also for township and light county work. When winter comes, it can be equipped with a reversible blade plow controlled hydraulically from the cab. Standard equipment includes a 9-ft. blade; 10- and 12-ft. blades are optional; approximate weight is 8100 pounds.

This motor grader is powered with a 22½-hp. International I-12 tractor, and is equipped with a special chain drive between the tractor axle and the driven axle which effects a 65% increase in the pulling power.



This shoulder finisher is effective and economical for grading and finishing accurately shoulders and back slopes on a highway job. Will do a mile a day, both sides of the road, with only 2 men. Insley Mfg. Corp., Indianapolis, Ind.



This shows the distinct lane markers in the new Midtown Hudson River vehicular tube and also the walls of hard, white terra cotta which diffuse the light into the roadway. Both lane markers and wall tile were furnished by Federal Seaboard Terra Cotta Corp.

KEEPING UP WITH NEW EQUIPMENT

Barber-Greene Bituminous Mixer and Finisher

Barber-Greene Company will exhibit at the Road Show the new 1938 Barber-Greene bituminous mixer which is used for both travel and central plant operation, and the Barber-Greene finisher. Motion pictures of many different jobs will be shown, laying particular emphasis on accurate proportioning, thorough mixing, automatic leveling, uniform spreading, and immediate compaction.

A number of sales engineers from the factory at Aurora, Illinois, as well as Barber-Greene district managers, will be in attendance.

International Tractors at the Road Show

The International Harvester Co. will have an "International Highway" exhibit at the Road Show, almost 500 feet long. At one end will be International-powered equipment used in initial excavating and dirt-moving work; then will come a series of other types of International-powered equipment, providing a picture of the work done by tractors, trucks and power units in the various steps of building a paved highway, and also the maintenance operations thereafter.

First will be a power unit and shovel with dump truck; then a four-wheel scraper pulled by a tractor; then a tractor and bulldozer; and following this, the installation of a culvert. Then a TD-35 diesel tractor and 10-ft. blade grader, a road roller, a tractor and front-end mounted shovel, a distributor, a 2-batch dump body, a paving mixer, etc.

Maintenance equipment shown will include a tractor and power mower, a grader working on the shoulder, and a trailer mounted air compressor.

Winter work of snow removal completes the picture, with tractors equipped with snow plows, crosswalk plows, and a truck for maintenance, but equipped with a snow plow and blade.

Underbody Scrapers and Graders

The Willett Mfg. Corp., of Plymouth, Ind., announce a complete line of new models of underbody Truck-Scrapers and Power-Reverse Truck-Graders, in sizes from 8' to 16' for mounting on all makes of trucks of 1½-ton and up for road and street maintenance work. These machines are available for operation by compressed air, hand hydraulic pump and full power hydraulic control.

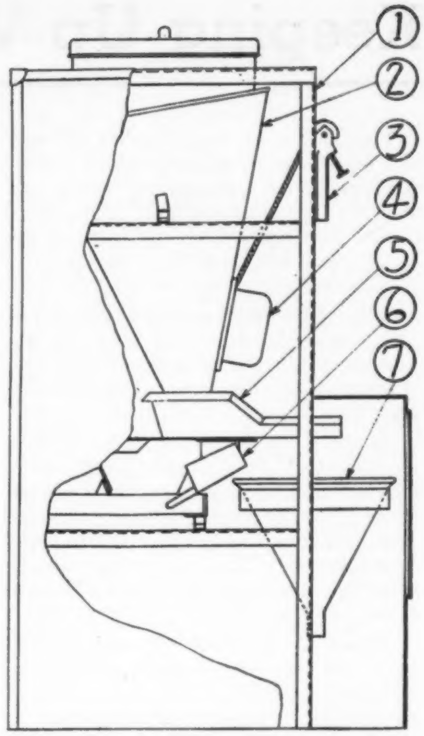
Extra attachments for these machines such as combination curved and flat moldboards on the same machine, special curved blades, special scarifier and roller attachments, special curved moldboards for black-top mix, etc., are available and can be readily attached and used thereon.

Syntron Dry Feeder Machine

Syntron Co. of 660 Lexington Avenue, Homer City, Pa., have a new model dry chemical feeder in a fully enclosed, dust tight, metal cabinet attractively finished in ivory colored enamel and polished aluminum.

The major feature is the use of their "Vibra-Flow" feeder conveyor to control the rate of feed of the chemical. The rate of flow is controlled by varying the current to the trough's electro-magnet through a rheostat that with a calibrated, indicating meter is mounted in a control panel on one side of the machine.

Material to be fed is stored in a built-in hopper equipped with a small, noiseless, electro-magnet vibrator that keeps the contents agitated to prevent bridging over and plugging up.



Syntron Dry Feeder: Figures refer to (1) cabinet; 2. hopper; 4. vibrator; 5. conveyor; 6. magnet 7. solution pot.

The unit operates on the ordinary 110 volt, A. C. lighting current, consumes little power and the only installation work required is to pipe water to and from its vortex type solution pot.

Capacity ranges from up to 100 lbs. per hour of light, fluffy material such as activated carbon, through up to 250 lbs. per hour of heavier material such as hydrated lime, on up to as much as 800 lbs. per hour of heavy material like alum, soda ash, etc.

Complete catalogue information is available from the manufacturer upon request.

International Tractor with Bulldozer.

Keeping up with New Catalogs:

Excavating Equipment: 32 pages of excellent illustrations and data on excavators at their pet job of dirt-moving. Sent on request to Koehring Co., 3026 West Concordia Ave., Milwaukee, Wisc.

Winter Heating Equipment: Littleford Bros., Cincinnati, Ohio. 4 pages; lists and describes salamanders of various types, concrete heaters, water heaters, heating torches, etc., and gives some good data on this cold weather work problem.

Tu-Ton Roller: C. H. & E. Mfg. Co., Milwaukee, Wisc. 8 pages. Describes the 2-ton tandem roller for sidewalk construction, patching, shoulder work, etc.

Crushing Plants: Austin-Western Road Machinery Co., Aurora, Ill. 4 pages. Describes the C-E-P (crusher, elevator and power) crushers in size from 10 x 16 jaw size to 21 x 38.

Keeping Up With the News

The Moles, an organization of men now or formerly engaged in tunnel, subway, sewer or sub-aqueous work, will hold the first annual dinner of the association January 15 in New York. Alex. M. Stagg, 143 Ocean Ave., Jersey City, N. J., is secretary.

Robert Bischoff, hyraulic engineer, has been placed in charge of all valve engineering for the Koppers Company's Western Gas Division at Fort Wayne, Ind.

J. D. Hitch, who has been resident engineer in Tokyo, Japan, for the Dorr Co. for the past eight years, has returned to New York to take charge of the Export Division, covering Japan, Australia and South America. T. B. Ford, who has been assisting Mr. Hitch in Tokyo will have charge of that office.

Elmer E. Barnard, consulting engineer, has moved his offices to the Lynch Bldg., Lynchburg, Va. Mr. Barnard specializes in sanitary engineering.

Frank Bachmann, who is in charge of sanitary engineering and marketing for The Dorr Company, is now on a world survey of sanitary engineering projects. At the present time Mr. Bachmann is traveling in India. G. C. Kaar, Vice President of Petree and Dorr Engineers, Inc., sugar engineers, accompanied Mr. Bachmann on the trip to India.

Dr. Anthony J. Fischer, research engineer for The Dorr Company, has returned to New York after a seven weeks' tour of sewage and water treatment plants in the Mid-West and on the Pacific Coast.

Arthur Terry, Managing Director of Dorr-Oliver N. V. and an executive officer of the other Dorr-Oliver companies in Europe, arrived in New York from The Hague on Monday, November 15th. Mr. Terry is making his annual visit to his associates in the United States. While here his headquarters will be the New York office of The Dorr Company.

Holway and Neuffer, consulting engineers of Tulsa and Albuquerque, have been employed to design and construct the large project for hydro-electric power and flood control on the Grand River near Pensacola, Oklahoma.

International Harvester Co. has moved its general offices to the new Harvester Bldg., 180 North Michigan Ave., Chicago.

C. Alfred Campbell has been made sales director for Marmon-Herrington Co., Indianapolis, Ind.

Effective January 1, Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn., became the Pioneer Engineering Works, Inc. There is no other change in the organization, corporation or personnel. Lewis W. Gerk is president.

Stuart Otto has been elected president of the American Centrifugal Corp., 115 Broadway, N. Y., manufacturers of dewatering equipment.

W. C. Flanders has been made sales manager of the Worthington-Gamon Meter Co., Harrison, N. J., succeeding G. H. Gleeson who resigned recently.

Lang Co., Salt Lake City, Utah, have been appointed representatives for Morris Machine Works, Baldwinsville, N. Y.

BOOKS

METALLIC CORROSION PASSIVITY AND PROTECTION, *by Dr. Ulick R. Evans; 720 pages; cloth; charts and tables; Longmans Green & Co., New York, N. Y.; $15.*

Summarizes existing knowledge relative to corrosion of metals by drawing upon investigations and writings of 1,700 authors and by utilizing data developed in research work since 1923 at Cambridge University. Written both for "practical men" and "pure scientists," the book divides into three sections, the first being devoted to scientific phases, the second to practical problems, and the third to quantitative treatment. The 15 chapters consider types and examples of corrosion, the influences of various factors, and methods of protection. Subject and author indexes; aims to present the latest information on a problem which costs industry many millions of dollars annually.

THE RETARDATION OF CHEMICAL REACTIONS, *by Dr. Kenneth C. Bailey; 478 pages; cloth; charts and tables; Longmans Green & Co., New York, N. Y.; $8.*

The author starts with the theory that it is as necessary for the industrial chemist to prevent the occurrence of undesirable reactions as it is to promote the favorable, and then proceeds to write what is believed to be the first general treatise on retardations. The 31 chapters give general information, and present research and other data of specialized interest. A bibliography on retardation is provided.

Remote Control Switches:

Bulletin 920A on Remote Control Switches has just been issued by Automatic Switch Company, 154 Grand Street, New York City. It is profusely illustrated with comprehensive drawings and photographs showing details of operations, accomplishments, advantages, etc. A copy will be sent on request.

Sewage Pump:

The Yeomans HNC pump is used for sewage, sludge, heavy liquids in industry, etc. It is horizontal, non-clogging, and furnished in capacities from 50 to 10,000 gallons per minute, and for heads of 100 ft. and higher. Write L. R. Behles, Yeomans Bros. Co., 1433 Dayton St., Chicago, Ill., for Bulletin 6220.

INDEX TO ADVERTISEMENTS

Readers' Service Department

These booklets are FREE to readers of PUBLIC WORKS.

CONTINUED FROM PAGE 64

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe, Cast Iron

406. Data on cast iron pipe for water works systems, in sizes from 1¼ to 84 inches, including information on useful life, flow data, dimensions, etc., Thos. F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Large Cast Iron

408. Handy cast iron pipe and fittings catalog contains A.W.W.A. and A.G.I. standard specifications for a wide variety of cast iron pipe specialties, both bell and spigot and flanged; also dimensions Lynchburg Foundry Co., Lynchburg, Va.

Pipe, Steel

409. A very complete, 60 page, illustrated bulletin on spiral welded pipe including lots of useful engineering information, hydraulic data, flow charts, specifications, etc., issued by American Rolling Mill Co., Pipe Sales Div., 1101 Curtis St., Middletown, Ohio.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joint Compound

414. A new bulletin has recently been issued giving full details concerning Tegul Mineralead, a quick-sealing, trouble-free compound for bell and spigot joints which permits immediate closing of the trenches. Write The Atlas Mineral Products Co. of Pa., Mertztown, Pa.

Taste and Odor Control

417. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps, fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for these three descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office Memphis, Tenn.

Protective Pipe Coating

422. Coal-tar Pitch Enamels for exterior and interior linings for steel water lines; highly resistant to water absorption, soil acids and alkalis. Technical specifications for materials and their application will be sent on request. The Barrett Company, 40 Rector St., New York, N. Y.

Pumping Engines

424. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Run-off and Stream-Flow

425. Excellent booklet describes and illustrates the latest types of instruments for measuring run-off, both from small areas for storm sewer design, and from large areas for determining water shed yield. Sent promptly by Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

428. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straight-line Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago, Ill.

Setting and Testing Equipment for Water Meters

430. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co., Wabash, Ind.

Snow Fighting

Plows

349. "V Type Sno-Plows for Every Size Motor Truck" describes and illustrates all features of the Frink V type plow, including the new power hydraulic control as well as the earlier types of lifting devices. Also describes and illustrates 14 styles of leveling wings and the different attachments which may be used in connection with them. Just issued by Carl H. Frink, Mfr., Clayton, N. Y.

350. One-Way Speed Sno-Plows are illustrated and described in a 4-page catalog. Features, specifications, methods of attaching. Carl H. Frink, Clayton, N. Y.

352. Snow Plows for 1¼ to 2-ton Trucks, Bulletin 1698; snow plows for 3-ton trucks, Bulletin 1699. Cover straight-blade reversibles, one-way and V plows. Controls; specifications. Austin-Western Road Machinery Co., Aurora, Ill.

362. The Sargent Handbook for 1938 contains sound, practical and valuable information on how to plow snow, and the types of plows, wings, etc., best suited for the various conditions of work. 86 pages. Sent on request. Maine Steel, Inc., South Portland, Maine.

357. Hydraulic Controls provide "fingertouch" ease in handling snow plows, and are simpler, quicker and permit higher operating speeds. For information on installation on present plows, ask for Bulletins 36-12 and 36-13. Vickers, Inc., 1412 Oakman Blvd., Detroit, Mich.

359. "Avoid Winter Tie-Ups." A folder describes various types of thawing equipment and their uses. Hauck Mfg. Co., 124-136 Tenth St., Brooklyn, N. Y.

Calcium Chloride

347. The Solvay Plus Four Treatment—"a low-cost skidproofing method that meets today's driving needs" is described and illustrated in a timely new bulletin just issued by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Salt

355. "Make Icy Pavements Safe With Rock Salt" is an authoritative booklet describing one of the most effective and economical methods of winter ice control. International Salt Co., Scranton, Pa.

Spreaders: Sand, Salt, etc.

365. New bulletin gives full details and illustrates Hercules Spreaders for quickly spreading sand, salt, cinders, chloride. Hercules Products Co., Galion, Ohio.

366. Flier shows pictures of Little Giant Sand Spreader in action and gives complete details. Illustrates method of spreading sand, cinders, salt, etc., quickly and evenly. Portable Elevator Mfg. Co., Bloomington, Ill.

Rainfall Measurement

432. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Bulletin RG and Instruction Booklet. Julien P. Friez & Sons, Baltimore, Md.

Screens

435. Water Screen Book No. 1252, describes traveling water intake screens and gives complete technical information about them. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Sludge Incineration

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection, 45 pp., ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Swimming Pool Equipment

444. Filters, chlorination, underwater lights and other supplies for swimming pools are very thoroughly described in literature and folders. Plans and layouts. Everson Filter Co., 214 West Huron St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Treatment

448. New 31-page catalog covers complete conveying, screening and reduction machinery for water purification and sewage treatment; describes and illustrates the design features of Jeffrey self-cleaning bar screen, combined screen and grinder, sewage screenings grinder, grit washer, conveyor type and positive discharge sludge collectors and green garbage grinder—includes installation views. Catalog 615, Jeffrey Manufacturing Co., Columbus, Ohio.

450. Standard Sewage Siphons for small disposal plants and PFT Rotary Distributors are new catalogs recently issued by Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill. The latter catalog contains typical plans and many illustrations of actual installations.

453. How to avoid sludge and scum troubles in settling tanks explained in detail in Book No. 1542—has excellent drawings and photographs, also specifications. Most important are the carefully prepared capacity tables. Link-Belt Co., 307 N. Michigan Ave., Chicago, Illinois.

454. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Valve Box Tops

475. "Cut the Cost, but Not the Pavement," is the theme of a new bulletin on Rite-Hite Valve Box Tops. Gives directions for forming new tops on valve boxes, quickly and inexpensively without digging up the old box. Just issued by Trohn's Supplies, Inc., 205 Hoyt Ave., Mamaroneck, N. Y.

Water Works Operating Practices

490. This is a reprint of two excellent papers by F. E. Stuart. One outlines a number of filtration and field practices of value. The other presents a lot of kinks the author has picked up in visits to more than 1,000 water works plants. Sent free by Activated Alum Corp., Curtis Bay, Baltimore, Md.

Drawing Supplies

495. Perspective and Isometric paper, graph paper, tracing paper, blue print hangers, automatic (irregular) curves, adjustable curves, multi-purpose charting papers, etc. Write for illustrated bulletin. Wade Instrument Co., 2246-PW, Brooklyn Station, Cleveland, Ohio.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

A.S.T.M. Standards on Cement:

This compilation, issued for the first time, gives in convenient form all the A.S.T.M. standard specifications and test methods pertaining to cement. The specifications cover portland cement, high - early - strength portland cement, natural cement and masonry cement. The methods of testing involve portland cement, chemical analysis, compressive strength of mortars and fineness.

A selected bibliography of literature on portland cement is given. This lists the more important sources of information on the subject. 96pp.; illustrated. Copies from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, at $1.00 per copy (heavy paper cover).

From the U. S. P. H. S.

Studies in Sewage Purification, VI. Biochemical oxidation by sludges developed by pure cultures of bacteria isolated from activated sludge. By C. T. Butterfield, C. C. Ruchhoft and P. D. McNamee. 26 pp. Ask for reprint 1812, Public Health Reports, which can be obtained without charge from Surgeon General, U. S. Public Health Service, Washington, D. C.

Ground Water Supplies. Progress report of committee of Conference of State Sanitary Engineers. 24 pages. Ask for supplement to Public Health Reports 124, as above.

Brick Pavements:

Though only a folder in appearance, this is essentially a short course in "why brick?" It covers 15 points regarding brick, giving essential information on wear, life, maintenance costs, salvage value, repair, safety and traffic marking. A note to Quincy Campbell, National Paving Brick Assn., National Press Bldg., Washington, D. C., will bring it to you.

Better Drainage:

"Your Guide to Better Drainage," issued by Armco Culvert Mfrs. Assn., Middletown, O., traces the history of corrugated metal drainage pipe from its invention in 1896 to date. The data in it would answer most any question Prof. Quiz could ask on the subject.

Index to advertisers appears on page 62

Bins & Batchers:

Blaw-Knox Co., Pittsburgh, Pa., has issued a 48-page wire-bound catalog covering portable batcherplants, knock-down batcherplants, bulk cement plants, truck mixer loading plants, central mixing plants, manual and automatic weighing batchers, bin gates, storage bins for aggregates and cement—and dimensional drawings for all of these will be furnished on request. This catalog is an outstanding job in appearance and content.

Portable Batching Plants:

Heltzel Steel Form & Iron Co., Warren, O., has issued this excellent 8-page catalog covering batching plants for batch trucks and truck mixers. It is captioned "When we say portable—We mean portable." Sent on request to B. M. Clark.

Sewage Treatment Equipment:

International Filter Co. has issued Bulletins 2410, covering the rotary distributor for trickling filters and the automatic dosing siphon, and 2420, covering the activator, which mechanically aerates, agitates and mixes. Either or both sent on request to International Filter Co., 59 East Van Buren St., Chicago, Ill.

Lubricating Contracting Machinery:

A 12-page complete article in "Lubrication," a house organ of the Texas Co., 135 E. 42nd St., N. Y., gives sectional views of commonly used equipment, showing lubricating methods. Recommends lubricants. Covers power plants, steam cylinders, diesel engines, gasoline engines and air compressors; also bearings—plain, roller and chassis part bearings; and gears and chains, transmissions and exposed and semi-exposed elements. Also a 32-page text on wire rope and gear lubrication. Sent on request.

Heat:

Johns-Manville, 22 East 40th St., N. Y., has issued an interesting book on this subject. Information goes clear back to antiquity, but leads up, of course, to the subject of insulating. Well illustrated, 48 pages. Sent on request.

Excavating Equipment:

Shovels, draglines and cranes are described and illustrated in an excellent booklet of 32 pages issued by Koehring Co., 3026 West Concordia Ave., Milwaukee, Wisc. Equipment is shown at work in large, clear illustrations, and the various parts of the equipment are illustrated separately and described so that the constructor can see just how the units are built. Sent on request. A complete presentation and worth study.